4.In8/4:S04/2
5-2

95th Congress
2d Session

COMMITTEE PRINT

COMMITTEE PRINT 95-75

SOLAR ENERGY AND TODAY'S CONSUMER

REPORT

BY THE

SUBCOMMITTEE ON OVERSIGHT AND INVESTIGATIONS

OF THE

COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE

HOUSE OF REPRESENTATIVES

NINETY-FIFTH CONGRESS

SECOND SESSION

DECEMBER 1978

U.S. GOVERNMENT PRINTING OFFICE
36-734 O WASHINGTON : 1978

COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE

HARLEY O. STAGGERS, West Virginia, *Chairman*

JOHN E. MOSS, California
JOHN D. DINGELL, Michigan
PAUL G. ROGERS, Florida
LIONEL VAN DEERLIN, California
FRED B. ROONEY, Pennsylvania
JOHN M. MURPHY, New York
DAVID E. SATTERFIELD III, Virginia
BOB ECKHARDT, Texas
RICHARDSON PREYER, North Carolina
CHARLES J. CARNEY, Ohio
JAMES H. SCHEUER, New York
RICHARD L. OTTINGER, New York
HENRY A. WAXMAN, California
ROBERT (BOB) KRUEGER, Texas
TIMOTHY E. WIRTH, Colorado
PHILIP R. SHARP, Indiana
JAMES J. FLORIO, New Jersey
ANTHONY TOBY MOFFETT, Connecticut
JIM SANTINI, Nevada
ANDREW MAGUIRE, New Jersey
MARTY A. RUSSO, Illinois
EDWARD J. MARKEY, Massachusetts
THOMAS A. LUKEN, Ohio
DOUG WALGREN, Pennsylvania
BOB GAMMAGE, Texas
ALBERT GORE, Jr., Tennessee
BARBARA A. MIKULSKI, Maryland

SAMUEL L. DEVINE, Ohio
JAMES T. BROYHILL, North Carolina
TIM LEE CARTER, Kentucky
CLARENCE J. BROWN, Ohio
JOE SKUBITZ, Kansas
JAMES M. COLLINS, Texas
LOUIS FREY, Jr., Florida
NORMAN F. LENT, New York
EDWARD R. MADIGAN, Illinois
CARLOS J. MOORHEAD, California
MATTHEW J. RINALDO, New Jersey
W. HENSON MOORE, Louisiana
DAVE STOCKMAN, Michigan
MARC L. MARKS, Pennsylvania

W. E. Williamson, *Chief Clerk and Staff Director*
Kenneth J. Painter, *First Assistant Clerk*
Eleanor A. Dinkins, *Assistant Clerk*
William L. Burns, *Printing Editor*

Subcommittee on Oversight and Investigations

JOHN E. MOSS, California, *Chairman*

JIM SANTINI, Nevada
THOMAS A. LUKEN, Ohio
DOUG WALGREN, Pennsylvania
ALBERT GORE, Jr., Tennessee
CHARLES J. CARNEY, Ohio
HENRY A. WAXMAN, California
PHILIP R. SHARP, Indiana
ANTHONY TOBY MOFFETT, Connecticut
ANDREW MAGUIRE, New Jersey
ROBERT (BOB) KRUEGER, Texas

JAMES M. COLLINS, Texas
NORMAN F. LENT, New York
MATTHEW J. RINALDO, New Jersey
DAVE STOCKMAN, Michigan
MARC L. MARKS, Pennsylvania
SAMUEL L. DEVINE, Ohio (ex officio)

HARLEY O. STAGGERS, West Virginia
(ex officio)

Thomas Greene, *Counsel to the Chairman*
Stephen F. Sims, *Special Assistant*
Deborah Webb, *Auditor* (on detail from the General Accounting Office)
Bernard J. Wunder, Jr., *Minority Counsel*

LETTER OF TRANSMITTAL

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON OVERSIGHT AND INVESTIGATIONS,
COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE,
Washington, D.C., December 5, 1976.

Hon. HARLEY O. STAGGERS,
Chairman, Committee on Interstate and Foreign Commerce,
Washington, D.C.

DEAR MR. CHAIRMAN: The attached report of the Subcommittee on Oversight and Investigations reviews active and passive solar technologies as they relate to today's consumer. In general, the report finds that consumers of active solar equipment require greater protection from equipment and installation defects. For potential consumers of passive solar, the major problem is effective access to this highly effective energy technology. Unless these problems are effectively addressed, solar energy will make only a modest contribution to U.S. energy supply in this century.

Sincerely,

JOHN E. MOSS,
Chairman, Subcommittee on
Oversight and Investigations.

Attachment.

Digitized by the Internet Archive
in 2013

http://archive.org/details/solarenergytoday00unit

CONTENTS

	Page
Introduction	1
Conclusions	3
Recommendations	4
Chapter 1: Problems Encountered in Residential Applications of Active Solar Technology	7
Chapter 2: Solar Standards, Codes and Certification	17
Chapter 3: Warranty and Disclosure Issues	27
Chapter 4: What an Active Solar Consumer Can Do Now	33
Chapter 5: Passive Solar Energy	43
Chapter 6: The Federal Government and the Solar Consumer	65
Appendices:	
Appendix A: "Summary of New England Electric Solar Water Heating Equipment", subcommittee staff memorandum, September 18, 1978	70
Appendix B: "Summary of Florida Solar Energy Center Survey of Solar Consumer Problems", subcommittee staff memorandum, September 15, 1978, plus attachments	75
Appendix C: "Summary of Problems in DOE-Funded Solar Energy Systems", subcommittee staff memorandum, September 18, 1978	88
Appendix D: Results of subcommittee questionnaire	89
Appendix E: Graphic displays of certain key findings of the subcommittee questionnaire	112

SOLAR ENERGY AND TODAY'S CONSUMER

Introduction

Many solar technologies have fully demonstrated their technical viability in today's marketplace. Recently enacted tax credits coupled with rising alternate energy costs are expected to motivate a growing number of consumers to purchase solar systems.

But potential solar consumers face important problems as they seek to buy effective, reliable and economical solar systems. The Subcommittee has found that the character of these problems is largely determined by the kind of system a consumer wishes to buy. Potential purchasers of active systems* must exercise care to assure that they get a system which meets reasonable performance expectations. Potential consumers of passive solar technology** are denied effective access to this important energy technology.

The potential active solar consumer is presented with a number of Federal financial incentives to purchase an active system. Demonstration grants and tax credits are expected to result in the installation of active systems in 2½ million homes by 1985. But consumers cannot assume that government financial support of active solar means that they can purchase such systems with the confidence they routinely enjoy when buying washing machines or air conditioners. Data on active solar water, space, and pool heating systems installed in several areas of the country reflect an unacceptably large number of problems. While it can be expected that solar designers, manufacturers, installers and government project managers have learned from these experiences, there is no immediate assurance that these problems cannot recur.

These problems with active systems present significant challenges to both government and consumers. For government, effective consumer protection mechanisms must be developed with all practical speed. Failure to do so risks injury to an increasing number of consumers as well as retardation of the deployment of solar technology. As in-

*In an active system, pumps or fans drive a working fluid through the system to produce useful heat or work. These devices have been employed to heat water and interior living spaces. With the incorporation of sophisticated heat engines, they have also been used to cool buildings.

**Primarily used for space heating, typical passive solar installations involve greenhouses and orientation of substantial glazing to the south. To store solar heat for use during evening hours, thermal masses, such as masonry or containers of water, are incorporated into passive building designs. These systems are "passive" because no mechanical equipment is required to make them operate.

dicated by the initial disappearance of heat pumps during the 1950's and early 1960's, important energy technologies can be lost for significant periods if initial consumer experiences are bad. Simply put, if the first family on the block has a bad experience with solar, it is unlikely that other systems will soon be installed in that neighborhood. This would be unfair to that first family as well as a Nation that is seeking to minimize its dependence on expensive, insecure supplies of foreign oil.

Specific challenges face government in the areas of solar standards, warranties, and demonstrations. Current efforts and needed initiatives with respect to these matters are discussed in separate chapters of this report.

For individual consumers of active systems, the immediate problem is to assure themselves that they are getting systems which are worth the money. Such systems are available and they can yield impressive savings on utility bills.[1] But while government and the youthful solar industry develop controls on poor equipment and installations, the best advice to a consumer is to ". . . educate yourself, know what you are doing, and work with familiar people."[2] A separate chapter of this report reviews the steps consumers can take now to help them make good on the promise of active solar technology.

Passive solar consumers face very different problems. This technology is only now beginning to take its proper place in Federal solar planning. Relatively simple and inexpensive, passive designs could be economically incorporated into a large number of residences and commercial buildings.

What this technology could mean to an individual consumer is suggested by the home of Dr. Douglas Balcomb in Santa Fe, New Mexico: electric baseboard heaters supplement his passive system and assure that inside temperatures never fall below 65 degrees. Despite below freezing temperatures outside, Dr. Balcomb's electric bill for auxiliary heat last winter, for the whole winter, was $38. In addition, he burned half a cord of firewood.[3]

But most consumers will not be able to take advantage of passive solar in their homes or places of work unless certain steps are taken now. The lack of easily available technical information and simple design tools currently limits passive solar to government laboratories and a small number of custom homes. Useful design and performance data must be developed and made available to the small contractors who build most of the Nation's residences and small commercial structures.

A lack of Federal tax and other incentives for expenditures on passive systems discriminates against passive solar consumers. While generally more cost effective than active systems for space heating applications, Federal tax credits are not extended to many passive systems. In the words of Congressman Gore:[4]

---

[1] "Consumer Protection Issues in the Development of Solar Energy," hearings before the Subcommittee on Oversight and Investigations of the House Committee on Interstate and Foreign Commerce, 95th Cong., 2d Sess. (Sept. 21, 1978) Tr. at 154 (hereinafter cited as Active Solar Hearings).

[2] Id. at 352.

[3] "Passive Solar Energy," hearings before the Subcommittee on Oversight and Investigations of the House Committee on Interstate and Foreign Commerce, 95th Cong., 2d Sess. (Aug. 11, 1978) Tr. at 25 (hereinafter cited as Passive Solar Hearings).

[4] Id., Tr. at 41.

It appears in summary that we give tax incentives to the least cost effective forms of solar energy (for space heating and cooling) and we deny tax incentives to the most cost effective form of solar energy.

This imbalance is a major problem. If allowed to continue, it could significantly distort American solar development.

The underlying premise of this report is that solar technology is ready for widescale consumer use. However, a significant increase in the use of solar energy is not assured. Government must act expeditiously to protect consumers from shoddy equipment and poor installations. Consumers must recognize that for a while they must exercise some care in purchasing active solar systems. Government must move ahead with programs which give consumers effective access to simple, passive solar technologies.

The Nation is poised to dramatically expand its use of solar energy. The actions we take now will largely determine the extent to which we can make good on the bright promise of solar technology.

CONCLUSIONS

The Subcommittee has drawn the following general conclusions:

(1) If properly designed, manufactured, and installed, many solar technologies are mechanically and economically feasible today.

(2) A significant number of design, manufacturing, and installation problems have been experienced by active solar space and water heating systems, particularly in residences.

(3) These problems have afflicted both federal solar demonstration programs and solar consumers in the private sector.

(4) These conclusions are particularly disturbing because the Federal government is encouraging consumers to purchase solar systems. Moreover, while there has been some effort to develop solar consumer protection mechanisms, a workable consumer protection plan does not exist.

(5) If the problems with solar systems are not sharply reduced, the popularization of solar energy could be set back for years. This would run counter to our national goals of reducing dependence on foreign sources of energy and improving the environment.

(6) Government programs have seriously underemphasized passive and lower cost active solar applications, which are the most cost effective and least mechanically troublesome of existing, commercially available solar technologies. This problem has been recognized, however, and some efforts have been made to correct the imbalance.

(7) Overall, DOE's solar demonstration efforts are still heavily weighted in favor of more expensive, less cost effective active solar systems. The DOE solar budget also over-emphasizes large, centralized technologies.

(8) The Federal agencies involved in solar energy, particularly the Departments of Energy and Housing and Urban Development, must rapidly and meaningfully summarize the problems encountered in solar demonstration projects and effectively disseminate this data to builders, contractors, installers, building code officials, and prospective solar consumers throughout the country. Absent

such a program, any boom in solar installations created by tax credits or other incentives in the National Energy Act could backfire if consumers continue to experience large scale problems.

(9) In addition to disseminating the technical lessons learned from solar demonstration programs, a massive coordinating job faces the Federal solar bureaucracy. Research and development programs must be closely linked with demonstration and commercialization efforts not only among several agencies in Washington, D.C., but vertically down through the regional solar energy research institutes, the states and local authorities.

Recommendations

The Subcommittee makes the following recommendations:

(1) Problems confronted in Federal solar demonstration programs should be identified and this information made available to the solar industry and consumers.

(2) Consumers and small business representatives should be provided travel funds and modest honorariums if required to assure that these interests effectively participate in the development of solar standards.

(3) The Federal Trade Commission should expedite promulgation of a Trade Regulation Rule providing minimum due process guarantees to those affected by standards.

(4) The Internal Revenue Service should take steps to provide that appeals by solar manufacturers from determinations that their equipment does not qualify for Federal tax subsidies are judged as rapidly as feasible.

(5) Rating and labeling standards must disclose any weaknesses in the data being presented.

(6) Every effort must be made to assure that standards do not unnecessarily limit consumer choice with respect to simple, low cost solar systems.

(7) Federal programs to train solar installers and inspectors should be continued and expanded.

(8) Short term warranties on equipment and installation should be required as a condition to qualification for the Federal solar tax credit. Longer term warranties, those in excess of one year, should be studied immediately to determine their costs and benefits.

(9) Warranty assurance programs should receive further evaluation and support.

(10) The Federal Trade Commission should promulgate a Trade Regulation Rule to control the sales claims of certain elements of the solar industry.

(11) Provision of maintenance and operating instructions should be required as a condition to qualification of a solar system for the Federal solar tax credit.

(12) Performance and design information about passive solar technology should be developed and widely disseminated to architects, builders, local governments, and consumers.

(13) Office of Management and Budget limitations on the acquisition of data needed to oversee Federal solar programs should be lifted with respect to questionnaires which seek information on market conditions and other essential data.

(14) Federal solar tax incentives should be extended to all of the passive solar technologies which are ready for consumer use.

(15) Consideration should be given to innovative mortgage instruments for passive solar buildings.

(16) The draft Domestic Policy Review, to the extent it is to be used as a solar agenda for the Federal government, should be recast to appropriately deal with consumer protection problems and passive solar technology.

(17) A single contact point should be established to help all interested parties deal with the current complexity of the Federal solar bureaucracy.

(18) Organization of Federal solar programs should be improved.

Chapter 1—Problems Encountered in Residental Applications of Active Solar Technology

A. OVERVIEW

A significant number of problems have been reported by several sources in the operation of active solar systems installed in residences. Most of the installations are hot water, space heating, or a combination of the two. These systems are considered the most technologically and economically suitable for current residential and commercial application. Water and space heating systems are also the most likely to benefit from the recently enacted Federal solar tax credit. If sales of these systems are stimulated by the tax credit or other Federal loan or purchase actions, by higher energy prices or other factors, and system purchasers continue to experience a significant number of problems, the impetus for rapidly expanded solar energy use is likely to be blunted.

The reported problems were primarily experienced in the last three years and reflect experiences in several parts of the United States.

B. THE NEW ENGLAND EXPERIMENT

The New England Electric System (NEES) began a solar water heating experiment in September 1975 to test the performance of commercially available solar water heaters. The utility wanted to see if solar hot water heating could aid in leveling peak electric power demand. By December 1976, nearly all of the 100 test units were installed in single family homes in Massachusetts, Rhode Island, and New Hampshire.[5]

Problems were encountered immediately. According to an October 1977 study of the experiment by Robert O. Smith and Associates, a professional engineering firm from Newton, Massachusetts; "results are still undetermined about demand peak effects because so much difficulty was encountered in the mechanical functioning of the solar water heaters."

The report concluded that only 15 of the 100 systems had functioned well. The other 77 systems had at least one major stoppage that required a technician to repair. Out of these 77, 20 had severely interrupted and unreliable service, and 23 had very low or no energy savings.

Average energy savings during the first year for all 100 systems was under 20 percent. Although the best 15 systems reduced water heating energy consumption by an average of 37 percent in a severe winter, this was not high enough to be economically attractive. The worst 15 systems averaged less than five percent savings. Some systems were made to work well after major modifications, but the budget

[5] For New England Electric System data including the observations of the engineering firm of Robert O. Smith & Associates, *see, Active Solar Hearings*, Tr. at 103 *et seq.*

for the experiment, originally set at $250,000, nearly doubled.

According to the consulting engineers:

> Most of the troubles encountered in this project are due mainly to flaws in installation, secondarily to flaws in the selection of component sizes and types, (and) thirdly to lack of inspections and adjustments which are necessary after installation. Some problems can be associated with generic types of system."[6]

According to Jack Meeker, Manager for Consumer Projects of the NEES, the second year of operation produced much better results. The 15 best systems are now saving consumers about 55 percent of their hot water heating bills. The worst 15 systems are saving approximately 20 percent. Mr. Meeker estimated that the 100 systems will average about 40 percent energy savings. However, the improved results were achieved only after the solar manufacturers and contractors either replaced or made major modifications to 72 of the 100 systems.

According to the study by Robert O. Smith and Associates, the following problems were encountered during the first year of operation:

Component:	*Number of problems*
Collectors	23
Piping	60
Valving	21
Tank, heat exchanger, electric heater	7
Dump or blower and motor	20
Controller	33
Miscellaneous	1

While the average system savings may become economically attractive to consumers in the NEES service system as early as next year,[7] the method of wholesale system modification or replacement is obviously not a realistic alternative for the individual consumer even if he or she were willing to wait several months or years while the system was made to work properly. The importance of correct total system operation was emphasized by Mr. Meeker:

> [I]f you have purchased a $2,500 system installed, and you have a $40 or $50 pump malfunctioning, and you do not know about it, that is going to negate any savings that you could expect to receive from solar.[8]

C. FLORIDA SOLAR ENERGY CENTER SURVEY

The Florida Solar Energy Center (FSEC), under contract to DOE, identified a number of solar users in Florida and surveyed their experiences. The work was undertaken as a part of an effort by elements in DOE to develop a consumer protection package to support solar demonstrations and commercialization efforts. In April 1978, the FSEC summarized the experiences as reported by 522 solar system owners. Over three quarters of the systems were installed in 1975 or later and over half were little more than a year old. Virtually all were residential installations and 80 percent were hot water systems. Solar consumers reported a high level of satisfaction with their systems: 67 percent were satisfied, only 12 percent were unsatisfied, and 21 percent reported having mixed feelings. According to Dr. Yarosh, Director of the Energy Systems Analysis Division of the FSEC, a number of the respondents probably shouldn't have been

---

[6] *Id.*
[7] *Active Solar Hearings*, *supra* note 1, Tr. at 26–27.
[8] *Id.*, Tr. at 20.

satisfied. 46 percent of the respondents reported having major or minor problems with their systems. The FSEC estimated that 22 percent had major problems.[9]

A subsurvey covering 216 of the respondents found that 111 or 46 percent reported that their problems had not been corrected at the time they were surveyed. It was not clear how long these problems had gone uncorrected, but the FSEC did find that for all respondents most of the problems occurred soon after installation and over 80 percent within the first year.[10]

The problems most often reported by consumers in the FSEC surveys were as follows: [11]

Problem type	Number of times reported	Percent of total survey	Percent of total problem cases
Freezeups	52	10	22
Water not heated to expectations	33	6	14
Water leakage	28	5	12
Poor installation	27	5	11
Unit never worked	23	4	10
Controller	16	3	7
Sensor	15	3	6
Service	15	3	6
Total	209		88

Dr. Yarosh, notes that the present solar owner is not typical of the likely purchaser of solar systems for residential use in the next several years. They make allowances for the fact that they are pioneers in a new energy application and that errors must be tolerated.[12] Dr. Yarosh believes that the solar industry has not yet penetrated what he thinks will be the average individual for the solar market. Individual residential consumers will account for an estimated 70 to 75 percent of all solar installations through 1990.[13] The government must take care to see that this mass market is not discouraged from considering solar energy because of operating difficulties. The success of solar energy depends on consumer confidence in solar as a viable energy source.

D. DOE-FUNDED SOLAR ENERGY SYSTEMS

Preliminary findings for 40 DOE-funded solar systems in residential and commercial installations are consistent with the NEES and FSEC results. DOE-funded systems, which include both air and water types, have experienced a large number of operating problems: [14]

Problem	Number of systems where possible	Cases	
		Number	Percent
Freezing	37	11	29.5
Collector to manifold leak	40	15	37.7
Controller malfunction	40	11	27.5
Collector malfunction (total)	40	22	55.0
(a) Flat plate type	36	20	55.5
(b) Concentrating type	4	2	50.0

[9] *Active Solar Hearings, supra* note 1, Exhibit 2. *See also* Appendix B.
[10] *Id.*
[11] *Active Solar Hearings, supra* note 1, Exhibit 2.
[12] *Id.*, Tr. at 13.
[13] *Id.*, Tr. at 11–12.
[14] *Active Solar Hearings, supra* note 1, Exhibit 3. *See also* Appendix C.

A much more extensive study by DOE, which summarizes 1,100 "experiences" reported by architects, engineers, project managers, and others associated with the heating and cooling demonstration program, was published in preliminary form in July.[15] It is the first comprehensive effort to summarize the actual problems and knowledge gained from the operation of this federally-funded program. As fundamental as such a compilation would seem, the report begins by admitting that preparation of the handbook was undertaken shortly before four DOE-sponsored regional "Solar Update" conferences "to fill a recognized void in information from solar demonstration projects."[16] But for the conferences, solar demonstration project experiences may not yet have been aggregated, even in a preliminary form. The study notes that while HUD provided experiences for inclusion in the study, a complete HUD report on the results of its residential demonstration program, which has many more units than the commercial demonstration program, is not yet available. In another major HUD residential program, the hot water initiative, the Department had no plans to monitor the results. This has belatedly been changed, and DOE has contracted with the Northeast Solar Energy Center to instrument about 30 installations in each of the eleven participating states.[17]

The DOE commercial demonstration program released its first Program Opportunity Notice (PON) in October 1975. The HUD residential demonstration program got underway a few months earlier. Results are as follows:[18]

[September 1978]

Type	Initiated	Operational[1]	Instrumented
Commercial projects:			
DOE program opportunity notice	108	25	25
Hotel, motel	37	4	0
Other	62	14	11
Residential projects:			
HUD	6,853	2,657	37
DOD	243	4	0
Other	3	3	1
Total	7,306	2,707	74

[1] That is, turned on at least once; this does not mean that unit is currently operational.

The delay in the production of a HUD report may stem from the very small number of instrumented units. Indeed, it is not clear how HUD will be able to effectively measure actual system performance, identify and tabulate problems and gauge utility savings.

In any event, the DOE report lists a considerable number of problems under three general headings: performance and design problems, cost and financial problems, and management and logistic problems. Each is summarized in table form:

---

[15] Solar Heating and Cooling Project Experiences Handbook, Preliminary Issue, Department of Energy, July 1978.

[16] *Id.*, Preface.

[17] For a critique of the HUD hot water initiative, *see* Susannah Lawrence, "The High Price of Federal Aid", *Solar Age*, November 1978.

[18] Department of Energy Memorandum from Ronald D. Scott, Assistant Director, Heating and Cooling, Solar Applications to Omi Walden, Assistant Secretary for Conservation and Solar Applications, September 15, 1978.

ITEMS OF CONSIDERATION / Project Phase	Preliminary Conceptual Design	Final Design	Construction Bidding/Re-Bidding	Installation and Construction	Operation Checkout	Operating Life
Pumps	1	21			6	2
Fans	3	2			1	1
Valves	1	34			4	1
Piping	2	30		1	3	7
- expansion compensators		18				
- connectors		10			2	1
- fluid swivel joint		3				3
Seals		2		1	3	1
Fluids (& corrosion inhibitors)	1	16		1	1	
Air Conditioners	1	3	1		1	
Heat Exchangers	4	18				
Cooling Towers		2				1
Line Insulation		25		2		
Storage Tanks	7	13	1	11	1	1
- location	1	10		2		2
- insulation	1	32		2		2
- internal fluid config.	3	18				1
- internal coating		11		1		1
Collectors	1	13		1		5
- configuration	7	38		1	2	3
- performance	6	8		2	5	8
- installation	5	38	1	3	1	3
- plumbing reqts.	2	17				
Instrumentation		1				
		1				
- information adequacy	1	5				2
- installation	1	5				1
- performance		4				2
Controls	2	13			1	4
- information adequacy		16				1
- installation		3		2		1
- performance	1	10		1	5	5
Interface with Conventional System	1	6				
- controls		5				1
- mechanical		7			1	
Building Structrual Interface	3	12		1		1
- roofing	1	26				
- other	2	21		2		
Other	7	33			6	8
Totals	65	549	3	34	43	69

Figure 1

Technical Performance & Design Problems Reported

Project Phase / ITEMS OF CONSIDERATION	Preliminary Conceptual Design	Final Design	Construction Bidding/Re-Bidding	Installation and Construction	Operation Checkout	Operating Life
Pumps						
Fans						
Valves	1			1		
Piping						
- expansion compensators						
- connectors						
- fluid swivel joint						
Seals						
Fluids (& corrosion inhibitors)						
Air Conditioners						
Heat Exchangers						
Cooling Towers						
Line Insulation			1			
Storage Tanks						
- location		2				
- insulation			1			
- internal fluid config.						
- internal coating						
Collectors	1		2			
- configuration		2				
- performance			1			
- installation		1	1			
- plumbing reqts.						
Instrumentation						
- information adequacy			1	1		
- installation						
- performance						
Controls						
- information adequacy		1	1			
- installation						
- performance						
Interface with Conventional System						
- controls						
- mechanical		1				
Building Structrual Interface	1	2		2		
- roofing						
- other						
Other	4	3	9	1		
Totals	6	12	17	5		

Figure 2

Cost/Financial Problems Reported

ITEMS OF CONSIDERATION / Project Phase	Preliminary Conceptual Design	Final Design	Construction Bidding/Re-Bidding	Installation and Construction	Operation Checkout	Operating Life
Pumps						
Fans						
Valves						
Piping						
- expansion compensators						
- connectors						
- fluid swivel joint						
Seals						
Fluids (& corrosion inhibitors)						
Air Conditioners						
Heat Exchangers						
Cooling Towers						
Line Insulation						
Storage Tanks						
- location						
- insulation						
- internal fluid config.						
- internal coating						
Collectors						
- configuration			1			
- performance				1		
- installation		1	3	6		
- plumbing reqts.			1			1
Instrumentation				1		
- information adequacy					1	
- installation		1				
- performance						
Controls						
- information adequacy						
- installation						
- performance						
Interface with Conventional System						
- controls						
- mechanical						
Building Structural Interface						
- roofing				2		
- other		1		1		
Other	10	5		4	1	
Totals	10	8	5	14	2	1

Figure 3

Management/Logistic Problems Reported

The report observes that the majority of design and performance problems were of a professional design nature and occurred in the final design phase.[19] 545 separate problems are listed that were discovered in this phase. The report notes that poor workmanship and the more stringent requirements of solar installations compared to normal plumbing and heating practices also contributed to many of the problems. The report identifies cost factors that were occasionally inadvertently omitted in system bidding and design, notes that considerable difficulties, including the propensity to damage collectors, were encountered in shipping system components, and describes some unanticipated problems in selecting and coordinating the several building trades that can be required to install a solar system.

After acknowledging that the heating and cooling demonstration program has provided "a learning experience" to professional architects, engineers, contractors, and tradesmen, DOE promises to publish more and better organized experience data. Such data, it is noted, "may be the most valuable 'product' of the early energy utilization program." [20] The Subcommittee agrees.

Unless widely and effectively disseminated, the practical lessons learned at considerable expense in the federal demonstration programs will be of limited benefit to any surge in solar energy use created in the next few years by the tax credit and various loan programs. Even worse, the failure to communicate these experiences to the rank and file of solar manufacturers and installers could mean that mistakes will be repeated, and that solar will become discredited much as the use of the heat pump was unnecessarily set back by initial negative consumer experiences in the 1950's.[21]

E. OVERSIGHT SUBCOMMITTEE SURVEY

The Subcommittee on Oversight and Investigations sent a 77-question survey to 781 solar owners in California, Michigan, and Wisconsin. 336 usable responses were received by the survey cut-off date. Of these, 255 were from California,[21a] 21 from Michigan, and 60 from Wisconsin.

Like the Florida study, the Subcommittee found both a high degree of satisfaction and a significant number of problems. For example, over 86 percent of the respondents were satisfied or very satisfied with their systems although over a third reported that the system leaked water or other fluid. The most significant problems are listed below. A tabulation of all the problems is printed as Appendix E.

---

[19] *Supra* note 15 at 63.
[20] *Id.*

[21] *Active Solar Hearings*, *supra* note 1, Opening Statement of Honorable John E. Moss.
[21a] As a condition to eligibility for California's 55 percent tax credit, solar suppliers must now provide minimum warranties and comply with other requirements. The effect of these eligibility criteria cannot be assessed from this data because systems surveyed in the Subcommittee questionnaire were generally purchased before these requirements were imposed.

SIGNIFICANT SOLAR SYSTEM PROBLEMS

Problem description	Answers received	Problem frequency	Percentage
System leaked water or other fluid	311	108	34.7
Pump or fan operates all the time	295	20	6.8
Pump or fan noisy	300	27	9.0
Controller operates inefficiently	295	43	14.6
Controller has been repaired	294	39	13.3
Controller has been replaced	296	30	10.1
Water condensed inside collector	294	66	22.4
House damaged during installation	298	19	6.4
Pipes or collector loosely mounted	298	38	12.8
Collector glass or cover has separated from the box	291	21	7.2

Since liquid systems use water or other fluid as the heat transfer matter, leaks reduce the effectiveness of the systems. Likewise, water condensed inside the collector limits the amount of solar energy that can be absorbed through the transparent collector face. Inefficient controllers can cause the system not to run when it should, which reduces solar energy collected during sunny periods.

Installation problems such as leaks, loose joints, or mounting and even house damage stand out clearly from this survey. The controller is also a major source of system malfunction although it is not clear whether this is due to improper installation, poor system design, or badly manufactured control devices. Another finding that appears to further underscore problems in the commercial solar installation industry is that the persons who did the installation themselves reported fewer problems than those who hired professionals to do the job. It may also be true, however, that the do-it-yourselfers took more time or did not count initial mistakes. For nine of the ten types of problems listed above, the do-it-yourselfers reported fewer problems (see Appendix E for a comparison).

Whatever the exact cause of manifestation, the absolute number of solar system owners who experienced problems with some regularity was disturbingly high.

Equipment problem frequency

Valid answers	314
Never (41.5 percent)	131
Seldom (39.9 percent)	126
Occasionally (12.0 percent)	38
Frequently (3.8 percent)	12
Always (2.2 percent)	7

While over 40 percent had fortunately never had equipment problems, 18 percent had suffered such problems at least occasionally. In cases where system owners had hired someone to install the system within the last three years, the figure was even higher—19.4 percent. Moreover, these figures must be considered minimums because it is highly likely that system owners are unaware of some problems. There are even a few instances of system owners being unaware that their systems were totally nonfunctioning.[22] Since most solar systems have automatic back-up systems, the solar owner often gets hot water from the tap or heat from the duct without being certain of the energy source. Few solar systems have the instrumentation necessary to show the exact contribution of solar energy to hot water heating, for exam-

[22] Subcommittee staff interview with Dr. Yarosh, May 1978.

ple. The hot water heating system may have a red light that indicates when the pump is running, but this does not mean that the system is producing all or any of the owner's hot water requirements. The addition of expensive instrumentation as standard equipment on a solar system would increase initial system cost, which is already a serious commercialization barrier, and would increase already lengthy economic pay-back periods.

A note of caution must be added to the above assessment of solar system problems. Since the majority of the solar systems covered by the Subcommittee survey are only a few years old or newer, the types of problems that would most logically be reflected are of an installation and system design nature. The Subcommittee survey should not be taken as a good indication of system or component durability, which results can only be obtained after several more years of operation. Moreover, the survey data was mostly reported by solar system owners, few of whom are likely to be solar engineers. Thus, while the results can be used to illustrate trends and major points, the reader is cautioned against over reliance on the data.

Chapter 2.—Solar Standards, Codes and Certification

I. PRODUCT STANDARDS

A. Overview

Product standards are a traditional way to assure minimum levels of product performance, safety and reliability. For the emerging solar industry, standards can be a blessing or a curse.

Standards which effectively shield consumers from shoddy products and inadequate installations would be a boon to the industry. A high level of consumer confidence would largely guarantee sustained high levels of industry growth.

But if standards are too rigid or rigorous, technical innovation may be substantially slowed. Superior, though non-conforming, products could be permanently excluded from the market to the extent that compliance with a standard is required by law or market pressures. In the rapidly evolving solar industry, limiting technical innovation is not in the interest of consumers.

To help assure that solar standards are neither too loose nor too rigid, several related strategies are emerging. The first is to substantially rely upon the voluntary consensus process for the development of solar standards. This process theoretically involves all of the parties interested in a product, manufacturers, small business and consumers, in the development of a standard. These interests are expected to reach consensus on a standard which does not unduly restrict industry while still protecting consumers.

The second strategy is to generate standards which allow broad latitude in the designs which will comply with their terms. Performance standards are preferred over prescriptive standards. For certain key product attributes like thermal performance, the trend is toward standards for testing and labeling rather than pass/fail levels of performance. An adequate full disclosure approach to such product attributes is the least likely to prejudice new or cheaper technology.

Each of these approaches to the development of solar standards has weaknesses which must be recognized and addressed. Significant reliance on consensus standards requires government to carefully monitor that process. Consumers and small businesses must effectively participate in the development of standards. Disclosures must be full and fair. Where data is soft, consumers must be made aware of the utility and limitations of the data being provided.

B. Current standards

The Solar Heating and Cooling Demonstration Act of 1974, P.L. 93–409, required the development of interim performance criteria for solar heating and combined heating and cooling components and systems in residential dwellings. Section 8 of the Act also made provision for the development of more definitive performance and testing criteria based on the experience that would be gained during the demon-

stration program. Currently HUD and DOE, with the assistance of the National Bureau of Standards and the National Aeronautics and Space Administration, have developed interim standards for solar heating, hot water and heating and cooling systems.

These solar standards have been incorporated into HUD's Intermediate Minimum Property Standards which regulate homes financed by the Federal Housing Administration or the Veterans Administration. In addition, systems receiving grants under either HUD's Hot Water Initiative or the commercial solar demonstration program must comply. In all, perhaps 20 percent of solar consumers are covered by mandatory Federal standards.[23]

In addition to the standards developed in accordance with P.L. 93–409, several standards have been issued by private standards development organizations. The American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) has developed test standards for the determination of the thermal performance of solar collectors (ASHRAE 93–77). This test protocol is relied upon by government and industry. In addition, ASHRAE has developed a standard for thermal storage devices (ASHRAE 94–77). The Sheet Metal and Air Conditioning Contractors Association has developed an installation standard for active solar systems. The Air Conditioning and Refrigeration Institute has issued a standard procedure for rating, labeling and certification of collectors.[24] It is expected that this standard will sooin be made obsolete by standards now nearing completion. A rating, labeling, and certification procedure for solar collectors being developed by the Solar Energy Research and Education Foundation (SEREF) is expected to be substantively complete by the end of 1978.

These standards are far from comprehensive. Neither reliability nor durability test standards for collectors have been generally agreed to. After these are developed, a rating and labeling standard could rapidly follow. System standards for thermal performance or reliability are not expected for some time.

Under the leadership of the American National Standards Institute (ANSI), working with the National Bureau of Standards, a division of labor and timetables have been established for necessary standards. To date, standards have been developed at an almost unprecedented pace. But the lack of key standards such as those on reliability indicate that this pace must be continued and accelerated.

At least five states, including California and Florida, have developed or are developing standards for use within their borders. In California, standards will determine eligibility for a significant 55 percent solar tax credit.

Despite this growing body of public and private standards, the prospective solar consumer without an engineering background is still hard pressed to know what to expect when a particular solar system is installed on his or her home. As summarized by Dr. Yarosh:

> We have found no coherent program in place that sufficiently informs and educates the potential consumer about near term technology * * * That is an enormous challenge. Nonetheless, we do not believe we have an effective and coherent program.[25]

---

[23] *Active Solar Hearings*, *supra* note 1, Tr. at 154.
[24] *Id.* Tr. at 183.
[25] *Id.*, Tr. at 86.

C. Problems with the private consensus process

Most product standards in the United States are developed through the voluntary, consensus process. This approach seeks to involve industry, design professionals, consumers and other affected groups in the development of a standard. In theory, all groups must not only be heard, but their legitimate concerns must be recognized and resolved in a satisfactory manner.

Solar standards developed through this process are expected to be incorporated into HUD's Intermediate Minimum Property Standard and the criteria for receipt of the Federal solar tax credit.[26] According to Mr. Carl Conner, Program Manager for Standards, Codes, Testing and Certification at DOE, "as new consensus standards come along, we will be adopting those." [27]

In effect, significant Federal benefits will be premised upon private standards. The importance of Federal tax credits to solar sellers is difficult to overestimate. The recently enacted Energy Tax Act of 1978 [P.L. 95–618], provides a tax credit for expenditures on any qualified "Renewable Energy Source" to the extent of:

(*a*) 30 percent of so much of such expenditures as does not exceed $2,000, plus

(*b*) 20 percent of so much of such expenditures as exceeds $2,000 but does not exceed $10,000.

A $2,000 system which meets "performance and quality standards" prescribed by the Secretary of the Treasury, in consultation with HUD and DOE, would cost the taxpayer $1,400. A $5,000 installation which conforms to these standards will cost a taxpayer $3,800.

For most solar manufacturers, failure to qualify for this credit will mean failure in the marketplace. As a consequence, the private consensus standards which will determine which systems qualify for the credit are of paramount importance.

Such reliance on private, consensus standards takes place at a time when there is growing debate over the private standards development system. It has been argued that private standards protect industry, not consumers. In some cases that is true. Ralph Nader has pointed out that certain lighting levels set by the Illuminating Engineering Society (IES), the trade organization for the lighting industry, are far above what is considered appropriate by opthalmalogists.[28] Such standards also often lag woefully behind the times. For example, it required eight years for a committee of the American National Standards Institute (ANSI) to approve an automatic flue damper for gas furnaces. This innovation can cut gas consumption in furnaces by as much as 23 percent.

Consumer advocates, academics, and recently the Federal Trade Commission have attributed such problems to inadequacies in the processes used to develop voluntary consensus standards.[29] While the

---

[26] *Id.*, Tr. at 639.
[27] *Id.*, Tr. at 639.
[28] Hearings on S. 825 Before the Subcomm. on Antitrust and Monopoly of the Sen. Comm. on the Judiciary, 95th Cong., 1st Sess., April 18, 1977, Statement of Ralph Nader.
[29] P. Maier & R. Nader, "The Case for Reforming Our Standards-Setting System", *New Engineer Magazine*, Jan. 1978. David Hemenway, "Remarks", *The Solar Market: Proceedings of the Symposium on Competition in the Solar Energy Industry*, Federal Trade Commission, pp. 88–90. Standards and Certification: Proposed Rule and Staff Report, Bureau of Consumer Protection, Federal Trade Commission, September 1978, Vol. 1.

anti-trust laws impose certain due process requirements upon standards development,[30] anti-trust litigation has proved to be a clumsy and ultimately ineffectual way to enforce these requirements.[31]

To address this problem, the FTC is now developing a trade regulation rule regarding standards and the standards development process. The emerging rule will require adequate notice to interested parties of the subject of meetings; guarantee a right to participate; provide that a standard setter indicate the basis for the standard; provide for appeals of decisions of non-compliance; and establish requirements with respect to the certification of products.[31a] These basic procedural safeguards should be mandated as soon as practicable.

But two concerns require special attention. The first is assuring effective participation by consumers and small business. Second, care must be exercised to assure that products which are equivalent or superior to those covered by a standard are not frozen out through inertia.

With respect to consumer participation, the Solar Energy Research and Education Foundation (SEREF), in the development of its thermal performance labeling standard for collectors has provided travel funds and modest honorariums to representatives of consumer interests.[32] It is expected that the American Society for Testing and Materials (ASTM), with the assistance of DOE, will provide similar funding to consumers in the development of some other solar standards.[33]

But other solar standards development organizations are not as effectively gaining consumer perspectives on important solar standards.[34] According to Mr. Butt of the Solar Energy Industries Association, this is "... because of the difficulty the consumers' representatives experience in being able to get to meetings. Often this is simply a financial difficulty." [35]

The legitimacy of private consensus standards depends upon the full, fair and effective participation of all important constituencies in the development of a standard. This is particularly true when a standard will be used to allocate a public benefit. At a minimum, the SEREF mechanism should be extended to the other organizations which are developing solar standards.

The second concern is grounded on experiences with other standards. While the anti-trust laws require that "standards reflect existing technology and be kept current," [36] "[i]nsufficient updating of standards is a perennial problem." [37] To deal with this problem, appeal mechanisms for technologies which are excluded by a standard are a key element in the FTC's developing trade regulation rule.[38] Government

---

[30] Legality of a Proposed Standards Certification Program, 78 FTC 1628 (1971); *Radiant Burners, Inc.* v. *Peoples Gas Light & Coke Co.*, 364 U.S. 656 (1961); *Silver* v. *New York Stock Exchange*, 373 U.S. 341 (1963).

[31] David Hemenway, "Remarks", *The Solar Market;* Federal Trade Comission, June 1978, p. 89. *See also* Hemenway, D. *Industrywide Voluntary Product Standards* (1975).

[31a] *Standards and Certification*, Bureau of Consumer Protection, Federal Trade Commission, September 1978. Vol. II.

[32] *Active Solar Hearings, supra* note 1. Tr. at 3.

[33] Staff interview with Mr. Jean Zerlett, American Society for Testing and Materials, November 14, 1978.

[34] *Active Solar Hearings, supra* note 1, Tr. at 181.

[35] *Id.*, Tr. at 181.

[36] *See*, Legality of a Proposed Standard Certification Program, 78 FTC 1628 (1971).

[37] *Id.*

[38] Proposed Trade Regulation Rule, FTC, 16 CFR 457.

must insist that appellate mechanisms employed by developers of solar standards will be both fair and rapid to avoid freezing out technical innovation.

The Energy Tax Act requires the Secretary of the Treasury to establish a procedure by which a manufacturer may request the Secretary to certify an item as eligible for the tax credit.[39] If private standards organizations are operating effectively, this mechanism will only be required in rare instances. But in all cases, judgments should be made rapidly. Because of the commercial importance of credits, delays in certification could mean the end of the firm making the appeal. If such assessments cannot be made relatively quickly, consideration should be given to interim certification of an item.

D. Rating and labeling standards

Serious reservations have been expressed about establishing minimum levels of performance for certain product attributes.[40] If minimum levels of thermal performance and durability are required, consumers may be inhibited in making choices on the basis of system cost versus system output.

The range of choices open to the active solar consumer could be very broad. Simple "breadbox" systems [41] can pre-heat the feed water for a traditional hot water heater. Costing little, these systems capture enough solar energy to make them very good buys for many consumers. Alternatively, more sophisticated, more expensive systems can provide the average family with more than half of its hot water requirements.

Existing HUD standards require that hot water systems produce enough 120°–140° F. water to meet about half the annual needs of the average family of four. This eliminates many inexpensive but highly cost effective systems.

It may be better to develop standards that prescribe a performance rating system without any minimum or maximum so that different technologies, designs, and manufacturing processes may compete freely. But such a full disclosure approach must be embraced with some sensitivity. Some product attributes such as safety cannot be appropriately regulated through disclosure.[42] For those attributes for which performance rating is appropriate, it is essential that consumers be made aware of the quality and utility of the information being disclosed.

Two problems identified during the course of the Subcommittee's hearing on active systems suggest the kinds of problems or limitations which should be disclosed to consumers. Both examples relate to information on the thermal performance of flat place collectors developed pursuant to ASHRAE 93–77.

The first is the problem of testing and rating only a part of a solar system. As Dr. Yarosh explained, rating only the collector is:

---

[39] P.L. 95–618, § 101. This section creates a new section 44C in the Internal Revenue Code of 1954. *See* § 44C. (c) 6(A) (ii).

[40] *Active Solar Hearings, supra* note 1, Tr. at 69.

[41] Breadbox systems generally involve one or more small tanks oriented to the sun. As water moves from tank to tank it gets warmer. Often the pressure to move this water is provided by the city water system itself. From the last tank in the series, water is piped to an ordinary hot water heater. By increasing feedwater temperature, significantly less fossil energy is required to heat a given quantity of water.

[42] *Id.*, Tr. at 186.

* * * akin to obtaining a mileage rating on an engine and trying to project the results to the operation of an automobile. Obviously, mileage will differ with the size and weight of the vehicle and the driving habits of the owner. The same principal applies to a solar system. No matter how efficient the collector, actual system output depends on a variety of factors including system design and sizing of components, and the operation and efficiency of each component.[43]

The second problem is variation in the results of tests of the same collector with the same equipment. Lumsdaine found that he could not eliminate certain sources of significant test error such as wind velocity and spectral distribution of radiation.[44] He found that these problems could result in performance tests which varied substantially.[45]

It would be best to eliminate these kinds of data problems through system tests and better tests. But to the extent such problems cannot be immediately eliminated, they must be fully disclosed.

II. CODES AND CERTIFICATION

A. Overview

Standard writing bodies are rarely regulatory entities. The power of a standard to determine behavior depends upon the mechanism by which it is enforced. In many cases, standards are incorporated into the building codes of states and localities. In other cases, compliance with a standard may be a condition to continued enjoyment of a license to practice a trade.

Each of these mechanisms has special problems. Incorporation of a standard into a building code is meaningless unless building code inspections are adequate. Trade licensing laws may or may not guarantee that an installation meets industry or government standards.

But a threshhold problem confronts consumers and the solar industry with respect to solar codes. Their coercive power may be used for good or ill. As a consequence, this Part begins with a discussion of the codes which are or may soon be applicable to solar.

B. Potential problems with codes

The existing national plumbing and electrical codes cover many of the materials and standard components of solar systems. However, many solar systems have unique characteristics that are not properly addressed by existing codes. According to Sheldon Butt,[46] plumbing codes are written to cover the flow of plain water at relatively high pressure, while the heat transfer process in many solar systems involves water, antifreeze, or other liquids at relatively low pressure. In terms of pressure, the existing code may be too restrictive, but nevertheless may be too lenient as regards the special precautions needed to handle monaqueous heat transfer fluids. Some building codes require that all walls of a structure be insulated to a certain level. This precludes many passive solar systems.[47] The International Association of Plumbing and Mechanical Officials issued in September 1976 a model solar code that contains special provisions for solar installa-

---

[43] *Id.*, Tr. at 148–149.
[44] *Id.*, Tr. at pp. 137–146.
[45] *Id.*
[46] *Id.*, Prepared Statement of Sheldon Butt.
[47] *Passive Solar Hearings*, *supra* note 3, Tr. at 45.

tions. The County of Los Angeles, California, has a similar code. According to Mr. Butt, however, "both have serious deficiencies." [48]

These experiences indicate that solar can be injured if codes are improperly or insensitively drawn. The danger is clear, but the Subcommittee believes that those dangers can be avoided. The DOE has initiated the development of a national model solar code, which is being drawn up by the Council of American Building Officials, a representative group of industry and standards development bodies. Consumer participation has also been provided for. Work formally began in September with a six month target date for the initial draft. While no assessment of the national model code can now be made, the code at a minimum will provide badly needed uniformity and establish a body through which continued alterations and additions can be affected.

If codes which have anti-solar provisions are a danger, an even more disturbing problem is that many states have no building codes at all. Only 23 states including about half of the Nation's population have some type of statewide building code.[49] Most of these codes are mandatory, but in several states adoption by local jurisdictions is voluntary. Moreover, state code enforcement is usually delegated to local authorities. The result is that in practice there is considerable variation among localities in the interpretation and implementation of seemingly similar code requirements. Florida's Dade County, which includes the City of Miami, has a county ordinance requiring solar installers to be licensed and collectors certified. According to Walter Dartland, a county official, there is little enforcement of this rule because of a lack of staff, expertise, and funds.[50] In a number of states and counties there are no building inspectors at all. In effect these areas have no codes to protect consumers.

C. Local inspections

A building code, no matter how well drawn, is only as good as its local implementation. The primary burden of enforcing codes is borne by local inspectors. The effectiveness of an inspection requirement has two aspects. First, the fact that an installation might be inspected has a certain deterrent effect in itself. The second, and most important aspect is the quality of the actual inspections.

To test the effectiveness of existing inspection standards, all respondents to the Subcommittee's questionnaire who reported that they lived in jurisdictions where inspections were required were identified. Of this group, all those whose solar system passed inspection on the first try were selected and a tabulation of their reported system problems compiled. While the 66 persons who fit this category had fewer or no problems in some categories than the average, the frequencies of problems were still high enough in many categories to suggest that existing inspection procedures are inadequate.

---

[48] *See* note 46.

[49] "A Preliminary Examination of Building Regulations Adopted by the States and Major Cities", NBSIR 77–1390, November 1977, National Bureau of Standards, Washington, D.C.

[50] Summary of Remarks at the Final Planning Session of the Solar Energy Consumer Protection Workshop, Atlanta, Ga., May 6, 1978, co-sponsored by DOE and FSEC.

PROBLEMS IN INSTALLATIONS WHERE INSPECTION WAS REQUIRED AND THE SYSTEM PASSED THE 1ST TIME (TOTAL=66)

Problem	Valid responses	Yes	
		Number	Percent
Water or other fluid leak	61	19	31.0
Pump or fan noisy	62	7	11.3
Pump or fan operates all the time	62	4	6.5
Pump or fan seldom operates	62	1	1.6
Pump or fan never operates	61	0	0
Controller operates inefficiently	61	9	14.8
Controller fails to initiate freeze protection for the collector	56	0	0
Controller has been repaired	62	8	12.9
Controller has been replaced	62	8	12.9
Piping has frozen or ruptured	59	3	5.1
Collector has frozen or ruptured	59	2	3.4
Water condensed inside collector	59	15	25.4
House damaged during installation	60	4	6.7
Collector has corroded	60	1	1.7
Piping or pipe joints corroded	58	2	3.4
Pipes, collector loosely mounted	59	4	6.8
Transparent part of collector is discolored	59	4	6.8
Collector glass or cover has separated from the box	59	3	5.1

This suggests the strong need to upgrade the understanding of local inspectors of the problems common to solar systems. Federal support of the training of local inspectors should be expanded to meet this need.

D. Trade licensing

The present installer licensing system, where some type of licensing requirement exists at all, appears inadequate based on the Subcommittee's survey. The following results were obtained:

WHICH OF THE FOLLOWING STATE OR LOCAL GOVERNMENT LICENSES DID YOUR SOLAR ENERGY SYSTEM'S INSTALLER POSSESS

Type of license	Valid responses	Yes
General contractor	160	101
Plumber	156	58
Electrician	154	28
Special solar	155	91

Note: 190 respondents hired someone to install the system for them.

Since 190 respondents indicated that they hired someone to install their solar systems, most installers had a general contractor's license and many appear to have possessed several licenses. Of particular interest is the high number of installers that were reported to possess some type of special solar installation training or certification. This may reflect the large number of respondents from California.

Since do-it-yourselfers reported fewer system operating problems than persons who hired contractors to install their solar systems, current trade licensing requirements and practices may not be adequate to prepare contractors to install solar devices. Rather, the "earn while you learn" principle seems to apply. Clearly, improved trade licensing procedures are needed. Another problem is that even if licensing procedures are improved, current license holders will almost certainly be grandfathered into the solar installation field. And as can be seen from the following example from Florida, licenses are not hard to obtain.

Although Florida law requires that anyone who desires to engage in the construction industry on a statewide basis must meet state certification requirements, and provides for 12 types of contractors, the law applies only to persons who desire to operate on a statewide basis. Other prospective contractors must only register with the Florida Construction Industry Licensing Board. No examination is required and regulation is left entirely to the competency and resources of local governments.[51] The ineffectiveness of existing trade licensing laws and procedures has led some observers to conclude that such regulations result more in a false sense of security than in consumer protection.

Since trade licensing is traditionally a state or local responsibility, the most appropriate, immediate Federal role is the provision of training to prospective installers and technical assistance to states. In addition, consumers must be made aware of the need to carefully oversee the work of their installer.

---

[51] Handout on Trade Licensing Laws, Consumer Protection Workshop, Atlanta, Ga. May 3–6, 1978.

Chapter 3.—Warranty and Disclosure Issues

1. WARRANTY ISSUES

A. Overview

The Subcommittee has identified a number of problems associated with solar warranties. The most important is that many solar consumers do not receive any warranty at all. Paradoxically, another problem is that some consumers receive multiple warranties. But when they turn to a particular warrantor for service, they find that whatever their problem, it was another firm's fault.

Federal policies toward solar warranties must balance a number of potentially conflicting consumer interests. The Federal government could require that purveyors and installers of solar systems provide substantial warranties. On the surface, such a policy is extremely attractive. But such mandated warranties run the danger of being so burdensome that they could force small competitors from the solar marketplace. An even greater danger is that consumers may be provided with warranties which offer only the illusion of protection.

The Subcommittee concludes that while individual consumers should insist on a warranty from both their installers and suppliers, the Federal government should not immediately require long-term warranties. However, it can immediately begin to deal with the quality of solar warranties through supporting programs which will stand behind the warranties offered by solar sellers.

B. Problems with solar warranties

The Subcommittee survey found that nearly one third of the respondents were not provided a written warranty. For those that receive warranties of any type and attempted to use them, all service requests were honored in almost 90 percent of the cases. There was no significant difference in warranty service provided by manufacturer, dealers, and installers.

Were written warranties given?

Valid responses	323
No (percent, 31.3)	101
Yes (percent, 61.3)	198
Don't know (percent, 7.4)	24

Have you used your warranty?

Valid response	183
Yes (percent, 37.7)	69
No (percent, 62.3)	114

What happened when you tried to use it?

All requests honored (percent, 88.4)	61
One honored, others not (percent, 7.2)	5
Many not honored (percent, 1.4)	1
No request honored (percent, 2.9)	2

36-734 O - 79 - 3

The absence of written warranties in nearly one-third of the cases probably stems from the current configuration of the solar industry. Very small firms are predominant.[52] Low entry barriers in conjunction with rising consumer demand engendered by solar tax credits are expected to bring more small companies into this industry.

Some firms design, construct and install their own systems either directly or through a franchise system. As a consequence, they can offer a warranty that covers all of the components of a system and its installation. Similar warranties are offered by system purveyors who sell and warrant a solar package which includes hardware and installation.

But in cases where a consumer gets separate warranties on the various components of a system and its installation, he can be caught in the middle. In the case of a system operation problem, it may be difficult for the consumer to identify who is at fault, and the manufacturer and installer may disagree. Improper installation can ruin or damage a well-designed and constructed collector, and shoddy equipment will not perform well no matter how carefully installed.

To avoid this problem, a consumer would be well advised to seek out a warranty on the installed system. Failing that, the consumer may require a "referee" mechanism by which the dilemma of who is at fault for a problem may be resolved. In California, an arbitration system for solar problems of this kind is administered through that state's Department of Consumer Affairs.[53] It is reportedly quite effective and may offer an important model for an appropriate "referee" role for government.

Warranty coverage varies significantly in scope and duration. Most solar vendors provide a limited warranty, which may allow them to cover parts but not labor, to impose a repair charge on either parts or labor or, in the extreme, to require the consumer to pay the labor and shipping costs of returning a defective part to the manufacturer. The latter type of warranty is in effect no warranty at all in the case of a bulky, hard to install item such as a solar collector.

C. Problems with minimum warranties

HUD now requires certain minimum warranty coverage be provided by the manufacturers and installers that participate in the fourth cycle of HUD's solar water heating demonstration program. While appropriate for a limited government program (this HUD demonstration is confined to 11 eastern states), mandating similar warranty requirements for all solar manufacturers and installers may not be wise. For example, HUD now requires a five-year warranty from the collector manufacturer against defects in material and workmanship. For manufacturers who have only been in business a few months or a few years, or who are producing a relatively new type of collector, the warranty provision will be extremely difficult to cost. If the added cost is too high, sales will be discouraged because front-end costs already make the economics of active solar systems precarious in many instances. If the cost is too low, the warrantor may not have

---

[52] A 1976 survey of 70 solar companies in Florida found that about 70 percent had been in business less than two years and that on the average they had 3.6 employees. *See also* Opening Statement of Dr. Yarosh, *Active Solar Hearings*, *supra* note 1.

[53] Subcommittee staff interview with Commissioner Ronald Doctor, California Energy Commission, September 9, 1978.

the resources to be able to cover the warranty and be forced out of business if problems occur. At present, a warranty is only as good as the company that issues it. A comprehensive warranty from an undercapitalized company may be worse than no warranty at all because the consumer believes that he or she is getting protection where little or none exists. Comprehensive warranties may also be anti-competitive in that they favor larger companies over small businesses.

There appears to be a trade-off between warranty coverage, cost, and the ability of the warrantor to perform as promised. But the problems of prejudice to small or innovative firms and hollow warranties appear to become more acute as the term of any mandatory warranty is extended. Since the surveys discussed in Chapter I indicate that most problems arise relatively soon after installation, requirements for short-term warranties would seem both worthwhile and appropriate. Such a requirement should include the workmanship of installers, a principal source of the problems identified in Chapter I.

According to Mr. Butt of the Solar Energy Industries Association, the industry "would not object" to some minimum guarantees being made conditions for eligibility for Federal tax credits.[54] But the level of protection to be appropriately required as a condition to eligibility is unclear. According to Mr. Sherman of HUD, the matter requires "an awful lot more study." [55] The Subcommittee believes such studies must be expedited and decisions made with respect to the proper terms and conditions of mandated warranties. In the interim, a relatively short-term warranty of no more than one year's duration should be mandated.

D. Warranty assurance

An initiative which could help the consumer get his rights without injuring the infant solar industry is a warranty insurance program. Such a program could step in and provide redress in cases in which a manufacturer, distributor, or installer has gone out of business or cannot otherwise carry out his warranty obligations.

The fund might be established by the solar industry, the federal or state governments, or it could be a joint effort, such as has been suggested in California.[56] Participation could be mandatory or voluntary. Contributions could be collected in different ways. The California proposal, for example, calls for quarterly premiums from each member based on retail sales from the previous quarter. The assessment of charges would be much more difficult were members offered differing warranties. The monies would be held in an escrow account and assessments could be adjusted periodically to reflect expenditures by the fund. A reward and punishment provision could be included that would raise or lower the premium on individual members depending upon the number of problems they experienced. If the governing authority of the fund believes a member company may be in hazardous financial position, it has been suggested that the governing authority have the power to order an audit by a certified public accountant. The fund must have the authority to suspend

---

[54] *Active Solar Hearings, supra* note 1, Tr. at 187.
[55] *Id.*, Tr. at 341.
[56] *See*, California State Assembly Bill No. 2982, Assemblyman Bates, introduced in the 1977–78 Regular Session.

or terminate membership although in cases of unintentional financial difficulty or bad business practice, termination of membership would seem to defeat the purpose of the fund.

Federal or state government reinsurance of solar manufacturer, distributor, or installer warranties has also been proposed as an alternative to terminating membership in the insurance fund under certain conditions or as a separate and distinct plan whereby the private warranty insurance of the individual companies would be backed up by the government. Such a plan would have to be carefully drawn to avoid the obvious temptation of private insurance vendors to ensure any and all applicants secure in the knowledge that the government would make good on any failures.

An insurance fund could establish an inspection service that would be the basis for an informal dispute settlement mechanism. Even in the absence of a fund, a technically competent, neutral third party solar inspection service would be of enormous benefit to solar consumers. While HUD has the equivalent of a toll-free solar hotline in the National Solar Heating and Cooling Information Center, the type of advice and information that any federal government agency can properly dispense is limited [57] and is not likely to include the kind of economic, technical, and legal guidance that the consumer really needs.

In addition to the inspection service, the insurance fund should have a mechanism for handling consumer inquiries and complaints. A general conciliation and arbitration procedure to cover disagreements, employing technical inspectors as needed, has been suggested. The fund would not, of course, limit any party's right to bring a court case except, perhaps, in instances of binding arbitration.

One existing model that includes a number of these features is the Homeowners Warranty Program (HOW), a voluntary program for builders established in late 1973 which is administered by a subsidiary of the National Association of Home Builders. HOW has an unsalaried Board of Directors, a broadly representative advisory board, full-time professional staff to coordinate the program at the national level and a series of local and State councils, which operate as wholly-owned subsidiary corporations of their respective builders' associations. HOW provides the home buyer with a written warranty against major structural defects from the builder, who is backed up by a private insurance carrier for the first two years. For the next eight years, the home owner is directly insured by a national insurance plan. The local council provides a neutral party to investigate the problem to attempt to resolve the dispute. If unsuccessful, the matter can be referred to the American Arbitration Association.

II. DISCLOSURE ISSUES

A. Before the sale

Consumers may confront a number of problems in dealing with solar sales material. This material appears to be the primary basis upon which consumers make their buying decisions. In responding to the Subcommittee's survey, respondents relied upon dealers in solar equip-

[57] *Active Solar Hearings, supra* note 1, Tr. at 193.

ment most often (61.8 percent). A magazine or journal article was next (56.5 percent), followed by a solar fair or exhibition (37.6 percent), a friend or neighbor (26.1 percent), an advertisement other than on radio or television (20.9 percent), and a home builder (19.9 percent). State agencies were next (17.8 percent), closely followed by other Government agencies (16.2 percent), which would include Federal. Previous owners, real estate salesmen, and radio and television advertisements were all cited in 5 percent of the cases or less.

In the key area of estimating the amount of utility costs that a solar system would save, respondents relied far more heavily on solar energy equipment salesmen (43.4 percent) than any other source of information. The next most frequently cited source for savings data was the respondents' own calculation (15.8 percent).

An example of the quality of the solar sales material which may be in store for some prospective solar consumers is the door-to-door sales campaign now being readied by the American Solar Power Products Corporation, headquartered in Kansas City, Missouri. According to a sales brochure dated October 15, 1978, the company plans to mass market a solar hot water, space heating and cooling system called Sun Star 92.[58] Promising no down-payment, easy financing, and a product "dependable as the sunrise" which will reduce heating bills "up to 70 percent or more" each month, the company has designed a sales pitch heavily laced with patriotic appeals and dire warnings of an imminent energy shortage and skyrocketing fuel prices from senior Department of Energy officials. The brochure employs highly dubious economic assumptions, including a prediction attributed to the Department of Housing and Urban Development that fuel oil prices will increase 18 percent each year for the next three years, to illustrate how purchasing a solar system costing several thousand dollars will "save" the consumer between $20,000 and $30,000 in ten years.

While the Subcommittee hopes that this brochure is an extreme example, it is clear that some regulation of sales claims is necessary. The Subcommittee has been made to understand that computer simulations of system performance and economic payback are widely employed in the selling of systems. Two popular computer programs, Sol-Cost and F-Chart, can project economic performance only within fairly broad ranges.[59] Consumers can be helped by these programs. But consumers must be made aware of the recognized limitations of these computer projections before they make a major investment on the basis of the estimates provided by them.

Increased consumer information prior to system purchase is the best remedy for such problems. While false and deceptive advertising and selling practices are generally prohibited under the FTC Act and its State equivalents, the task of establishing the fraudulent practice in each case is laborious and results only in a cease and desist order. The FTC should give serious consideration to promulgating a Trade Regulation Rule for solar sales, which would prescribe basic disclosure requirements, and provide for civil penalties or require violators to make restitution to injured customers. Disclosure requirements could include warranty coverage, operating and maintenance instructions,

---

[58] A copy of the brochure is retained in the Subcommittee files.
[59] *Active Solar Hearings, supra* note 1, Tr. at 147–148.

explanation of thermal performance and other test results or ratings, representations as to eligibility for tax credits and clear and full explanations for any cost or energy savings claims.

B. After the sale

The majority of solar consumers sampled by the Florida Solar Energy Center did not receive sufficient operating and maintenance instructions. The Subcommittee found in its survey that in over 47 percent of the cases consumers were not provided with operating and maintenance instructions. When provided, however, the instructions appeared useful. Over three quarters of those who received such instructions had attempted to use them. Over one-third found the instructions excellent and only 4 percent reported the guidelines were inadequate.

Failure to provide simple operating and maintenance instructions to consumers is inexcusable. Requirements with respect to the provision of such information should be made a condition to eligibility for the Federal solar tax credit. In all cases, individual consumers should demand this information from their suppliers.

Chapter 4.—What An Active Solar Consumer Can Do Now

A. Overview

There are many steps a consumer can take to ensure that he or she is making a wise solar investment. These include acquainting oneself with how solar systems work, making a simple economic analysis, and comparing the features, prices and warranties offered by different system suppliers or installers. By exercising care in the purchase of a solar system, consumers can ensure that what they buy will work and work economically.

The first step is to learn about solar energy. Consumers should familiarize themselves with the designs of the various systems available. This can be done by obtaining information from the National Solar Heating and Cooling Information Center (800–523–2929 or in Pennsylvania, 800–462–4983), the state energy office, the local or regional solar energy association, local community groups active in the solar field, or from local solar professionals.

A simple economic analysis should then be made to see if the solar system would be economical. One should compare the approximate cost of the system with the potential savings in monthly utility bills over the long-term. When making these simple calculations, consumers should consider potential tax credits, special low-interest loans and other subsidies which may be available from federal, state or local agencies. These subsidies can significantly reduce the initial capital costs of the system. Guidance in making these calculations can be provided by the local utility or various books on buying solar, some of which are listed at the end of this chapter.

In considering the purchase of a solar system, consumers should make sure that other more cost-effective energy investments have been made first. These include insulation, storm windows or doors, caulking or weatherstripping, a thermal blanket for the hot water heater, water heater timing devices, and automatic setback thermostats. Otherwise, the savings from a solar system can often be achieved at lower cost.

In choosing a supplier or installer, one should find out about the firms' track records, experience, training and local reputations in the solar field. This can be done by inquiring directly from the firms and from consumers who have previously purchased solar systems from them. The National Solar Heating and Cooling Information Center can provide to a consumer a listing of solar manufacturers, contractors and installers and of solar installations located in his or her state. While being listed does not represent an endorsement, these lists are a useful source of information.

Consumers should be sure to obtain a written cost estimate of a complete system with an itemized breakdown of all costs, including installation. The costs of any regular maintenance required should also be ascertained. In some cases, a service contract may be offered by the

installer, in which case the precise terms of the contract and who will be making the repairs should be determined. It is strongly recommended that some part of the purchase price be withheld until the system has operated well for a week.

A written warranty is a must. When examining the warranty, the consumer should find out what the warranty covers and what it does not cover. A five-year warranty for the solar collector is reasonable. However, one should be somewhat wary of long-term warranties; they may be misleading. One should be sure that the company with which one is doing business can back up the warranty. A warranty is only as good as the company which offers it. It is very desirable to have a single warranty which covers both components and installation.

The system chosen should be designed for the particular needs of the house while considering local climate and topography. It may be wise to consult an experienced solar professional in choosing the most appropriate design. Also, the consumer should make sure that the supplier agrees to ensure that the system conforms to local building and zoning regulations.

Once the system has been installed, it should be thoroughly tested by the installer and inspected by local building authorities. The system should include simple monitoring equipment so that proper operation can be monitored throughout the life of the system. The consumer should obtain an owner's manual which clearly explains the operation of the system.

By taking these steps consumers can be substantially assured that they are acquiring a system which can save hundreds, perhaps thousands, of dollars over time. For further assistance in buying solar systems, consumers may wish to review the more specific suggestions of the New England Electric System as well as consult the information sources listed at the end of this chapter.

B. Consumer suggestions provided by the New England Electric System

During the Subcommittee's hearing, Mr. Jack Meeker of New England Electric made many valuable suggestions for consumers purchasing solar systems. The suggestions pertain specifically to water heating and are summarized in a short New England Electric brochure. As a supplement to the Subcommittee's suggestions, the contents of the brochure follow:

SOLAR WATER HEATING CONSUMER GUIDE

BUYING A SOLAR WATER HEATING SYSTEM

PURPOSE

Solar energy provides several major benefits: (1) reduction of national dependence on imported oil, which is subject to supply interruptions and rapid price increases, (2) minimal environmental damage, and (3) reduction of the drain on our limited oil and natural gas supplies. The means of using solar energy to supply heat and hot water are presently available, but the rapid expansion of solar technology has created a new industry whose members vary widely in technical and business competence.

The following recommendations are given by a task force concerned with improving solar hot water systems. They are based on a review of experience with installation and operation of 100 systems, sponsored by the New England Electric System companies, and on the members' knowledge of the solar industry.

Because no condensed statement can replace public education on solar energy's potential and problems, users are advised to consult the many reference books available before buying, particularly, "Buying Solar", (National Technical Information Service PB-262 134); or call the National Solar Heating and Cooling Information Center's toll free hot line at 1-800-523-2929.

This booklet has been prepared in part with funding from the U.S. Department of Energy through the Solar Technology Transfer Program at Brookhaven National Laboratory. It may be reproduced without further permission. Acknowledgment is made of the special contribution made by the New England Electric System companies in permitting a review by Robert O. Smith, P.E., of the data obtained over many months of experience with systems from a number of solar manufacturers and contractors. Other contributors include: the Massachusetts Solar Action Office, the Solar Energy Industries Association, Oak Ridge National Laboratory, the Franklin Institute, and the U.S. Department of Energy. Individuals working on the consumer committee were Messrs. Ryc Loope of Sunworks Inc., Jack Meeker of New England Electric System companies, William Osborn of the Massachusetts Solar Action Office, Gordon Preiss a consultant to Brookhaven National Laboratory, Burt Swerdling of Grumman Sunstream Division, Ms. Roberta Walsh, Chairperson of the U.S. Department of Energy.

The material herein presented does not represent a consensus of the disparate viewpoints of the contributors, but summarizes useful suggestions from each. Suggestions for its improvement are solicited.

W.L. Graves
Brookhaven National Laboratory
Upton, NY 11973

SELECTING A SOLAR WATER HEATING SYSTEM

1 Estimate the total installed cost including materials, labor, permits and fees, and service contract charges based on the contractor's written commitment.

2 Obtain in writing an estimate of the system's performance, giving the total solar energy supplied for the year. Two widely used methods of calculating this yield are "The F-chart Computer Program" of the University of Wisconsin and "Solcost" of the U.S. Department of Energy.

This figure should be considered with the price quoted by the contractor in selecting a system. Family and house size should be factored into the decision.

The system's performance should be calculated and preferably tested by an independent, recognized laboratory in accordance with HUD minimum property standards. The calculations should allow for your location and family size.

3 Be sure the collectors face as near true south as possible and are unshaded from 9:00 a.m. to 3:00 p.m.

4 Select a system with well-insulated pipes (R-4 or better) and tanks (R-11 or better).

5 Select a system with adequate protection against freezing. If antifreeze is used, note that toxic materials must be separated from the domestic hot water by a double wall design. If freeze protection depends on the electric operation of a valve, require firm assurance of the reliability and service life of the valve. If the system drains to avoid freezing, check the pitch of all piping exposed to low temperatures to avoid low pockets of water which may freeze and burst.

6 Select a system whose proper operation can be monitored. An elapsed time meter on the pump and thermometers in the storage tank and in the pipes to and from the collector are desirable. The meter should read under 80 hours per week. The thermometers should show a sizeable temperature increase while the pump is running. On a bright, sunny day, an increase of 15° to 25° is normal.

7 Require the contractor to pressure-test the system for leaks. Very little loss of pressure should be observed in tests of one hour at 125 psig, or of 24 hours at 25 psig.

8 Specify in the contract that final payment is to be made after the system has operated satisfactorily for seven days and has then been inspected by the contractor.

9 Check your state energy office regarding federal, state, and local tax relief and subsidies for your system.

SELECTING A SOLAR CONTRACTOR

1 Consult several solar contractors before making a selection. While time-consuming, it is essential in obtaining quality work at a fair price.

2 Obtain a written quote on the complete job. Consider the cost along with the other factors given below.

3 Consider the contractor's location. A local office is important in providing a prompt response to service calls and also will be interested in protecting its local reputation.

4 Determine the contractor's qualifications. Experience in installing solar hot water systems as well as in such closely related fields as plumbing and heating is desirable. His support from the manufacturer of the solar equipment is also important and should be verified by a certificate of training or by supervision or inspection of the job by a representative of the manufacturer.

5 Establish the contractor's local reputation. Request references and check them regarding satisfaction with the installation, the amount of service that has been required, and the promptness of response to requests for service. Inspect some installations if possible.

6 Require a written warranty. Read carefully and consider the provisions of the warranty. Disregard unwritten assurances. Prefer a full to a limited warranty; on a limited warranty find out exactly what is covered (federal law requires that all conditions be stated clearly). Require a warranty on parts and labor of at least one year. Try to obtain a warranty on the collectors, heat exchanger (if any) and tank of five years. Determine the obligations of the manufacturer and contractor. Seek a warranty that is transferable to a new owner of the property. Obtain a commitment for a response to warranty calls within 15 days.

7 Consider the availability, terms and cost of a full system service contract.

8 Require an Owner's Manual. The manufacturer should provide a clear and complete manual which the contractor should review with the homeowner.

9 Obtain written agreement that final payment will not be made until after the system has operated normally for seven days and then been inspected by the contractor.

Sources of Additional Information

The National Solar Heating and Cooling Information Center; P.O. Box 1607; Rockville, Maryland 20850; 800–523–2929 or in Pennsylvania, 800–462–4983.

The Buy Wise Guide to Solar Heat, Floyd Hickok, editor, Hour House; P.O. Box 40082; St. Petersburg, Florida 33743; 1976, 121 pp., $9.00.

Buying Solar, Federal Energy Administration, available from the Superintendent of Documents, U.S. Government Printing Office; Washington, D.C. 20402; Stock No. 041–081–00120–4, 1976, 71 pp., $1.85.

Homeowner's Guide to Solar Heating and Cooling; W. M. Forster, Tat Books; Blue Ridge Summit, Pennsylvania 17214; 1976, 196 pp., $4.95.

The Solar Decision Book: Your Guide to Making a Sound Investment, Richard H. Montgomery; Don Corning Corporation; Midland, Michigan 48640, 1978, $10.00.

Solar Hot Water Heating and Your Home, available from The National Solar Heating and Cooling Information Center.

Chapter 5.—Passive Solar Energy

A. Overview

The fundamental problem confronting most potential consumers of passive solar is that they are denied effective access to the technology. Design and performance information is still largely confined to government laboratories. Even if a consumer finds one of the few designers or builders who can design or build an effective passive system, the consumer will probably be discriminated against in seeking Federal solar tax credits.[61]

What the ready availability of this technology could mean to an individual consumer is suggested by the home of Dr. Douglas Balcomb in Santa Fe, New Mexico. Electric baseboard heaters supplement his passive system and assure that inside temperatures do not dip below 65 degrees. Notwithstanding below freezing outside temperatures, Dr. Balcomb's electric bill for auxiliary heat last winter, for the whole winter, was $38. In addition, he burned half a cord of firewood.[62] Dr. Balcomb reports that his home provides "a very comfortable environment." [63]

For a Nation of consumers, passive solar could displace the equivalent of one half million barrels of oil per day by the year 2000. If appropriate actions are taken now, the Nation could reasonably expect to incorporate passive solar into 10 million of the projected 40 million new buildings which will be constructed through 2000. In addition, it also appears feasible to passively retrofit 10 million of the present stock of 70 million buildings.[64]

But neither individual consumers nor the Nation will enjoy the benefits of this technology unless actions are taken now to deal with the problems of information and Federal financial incentives. Information to be useful must be targeted on small contractors as well as consumers and local governments. Since the technology is somewhat difficult to precisely define, the targeting of financial incentives is more difficult but no less necessary than in the case of active solar.

Because of the importance of a knowledge of the technology to an understanding of these policy problems, this chapter begins with a review of the passive solar technologies that appear ready for widespread use. Only after a review of the technology and its costs does this chapter consider the specific problems confronting the potential passive solar consumer.

---

[61] *Passive Solar Hearings, supra* note 3, Tr. at 29–30.
[62] Wade Greene, "Solar Refractions", *New Times,* May 29, 1978, p. 5.
[63] *Passive Solar Hearings, supra* note 3, Tr. at 25.
[64] *Id.,* Tr. at 29.

36-734 O - 79 - 4

B. The technology [65]

A passive system is "one in which the thermal flow is by natural means, that is by radiation, by conduction or by natural convection.[66] According to Donald Watson, architect and solar author: "A passive system has only one moving part, the earth moving around the sun." [67]

But this movement provides significant opportunities to solar designers. As suggested by Dr. Balcomb, "the sun angles work in our favor." [68] The sun is higher in the sky during the summer than in the winter. The sun also traverses the sky to the north of true east-west during the summer and well to the south during the winter.[69]

This solar geometry means that a simple overhang can allow warming solar energy to be admitted through a window during the winter but keep it shaded during the summer. Putting windows on the south side will provide warmth in winter without necessarily increasing indoor temperatures in the summer. In fact, proper orientation alone can make a building 10 degrees warmer in the winter and 10 degrees cooler in the summer.[70]

There are currently five generic types of passive solar systems which appear to be ready for widespread use. The first is a direct gain system. At its simplest this system involves locating windows on the south side of a building. The sun shining through the windows heats the interior during the day much as the interior of an automobile is heated on a sunny, winter parking lot. Excess energy can be stored through heating floors or walls within the structure for nighttime use.[71]

The concept is simple but effective. An example of its use is provided by a house in Hinesburg, Vermont.[72]

It has double glazing to minimize heat loss through the windows and a massive central fireplace wall to store solar heat for use during the evening hours. This system offsets all of the daytime heating loads while providing some heat at night.[73]

A New Hampshire warehouse suggests a cost effective commercial application of this approach.[74]

Double glazed acrylic material allows the sun in. The sun's heat energy is stored in the materials which are located within the warehouse.[75]

The second type of system is a mass storage wall. This is sometimes referred to as a Trombe wall after the French designer, Felix Trombe, who popularized the concept.[76]

---

[65] This section is largely based upon the testimony and slides presented to the Subcommittee by Dr. Douglas Balcomb, Los Alamos Scientific Laboratory. For further elaboration on the technology, the reader should consult the Passive Solar Hearing at pp. 2–29 or the article written by Dr. Balcomb entitled "State of the Art in Passive Solar Heating and Cooling", Los Alamos Scientific Laboratory, Los Alamos, N.M. (87545), 8 pp.

[66] *Id.*, Tr. at 3.

[67] As quoted in an article by Wade Greene entitled "Solar Refractions", *New Times*, May 29, 1978, p. 4.

[68] *Passive Solar Hearings, supra* note 3, Tr. at 2.

[69] *See* note 67.

[70] *Passive Solar Hearings, supra* note 3, Tr. at 2.

[71] *Id.*, Tr. at 3.

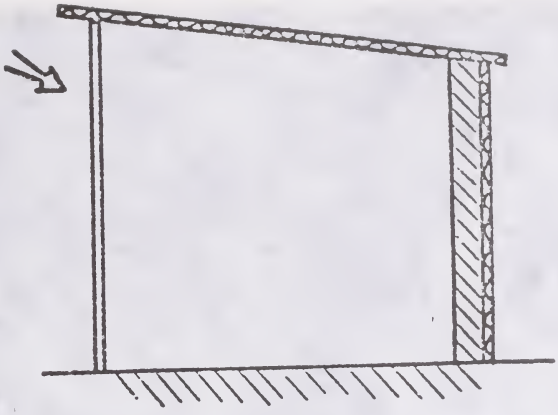
[72] *Id.*

[73] *Passive Solar Hearings, supra* note 3, Tr. at 3–4.

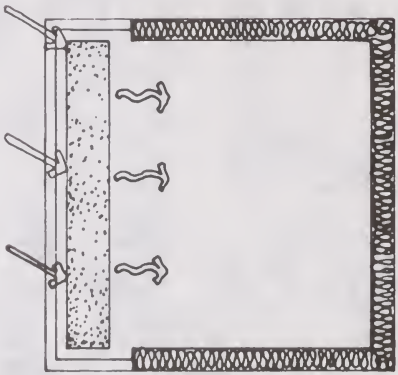
[74] *Id.*, Tr. at 7–8.

[75] *Id.*, Tr. at 7.

[76] *Id.*, Tr. at 9–11.

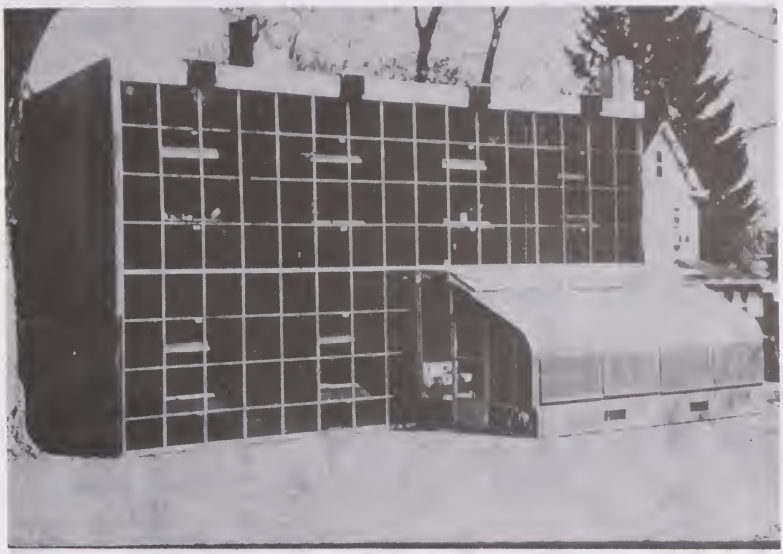


Mass Trombe Wall



With this system the heat storage mass is located directly behind the glazing. The heat absorbed by the wall is diffused through it by conduction and transmitted to the living space through radiation and convection. Locating the thermal mass immediately behind the glazing solves the problem of overheating during the day which has been experienced with direct gain systems which supply a substantial percentage (solar fraction) of a structure's heating needs.

An example of this system is provided by a home in Princeton, New Jersey: [77]



This house is of well-insulated frame construction except for a 15-inch thick Trombe wall covered with double glazing on the south side. Six windows penetrate the wall to provide interior light for this side of the building. This system provides 80 percent of the heat required by this home.

The thermal mass of the wall need not be concrete. Water containers have been successfully employed by a company located in Star Tannery, Virginia.[78] The south-facing brick walls of old factories have been turned into effective Trombe walls through the addition of double glazing. The flow of heat during the day is controlled by opening and closing the original windows.[79]

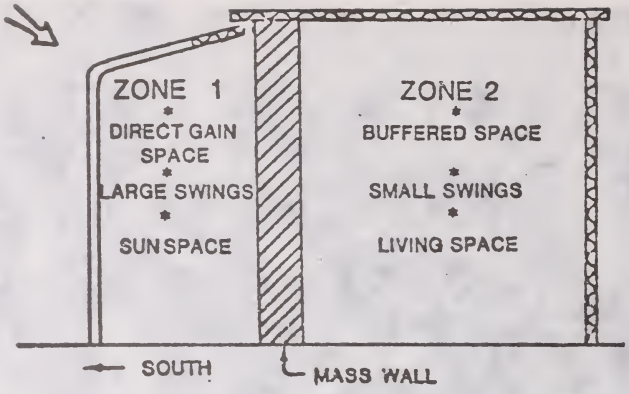
The third design is the enclosed sun space or greenhouses.[80]

With the living area separated from the sunspace, heat diffuses through the wall mass much as it does with a Trombe wall. This system can be simply "bolted on" to existing structures. As a consequence, it has been characterized as a "tremendously viable and effective concept for retrofitting or upgrading an existing building." [81]

An example of a retrofit greenhouse is provided by this wood and fiberglass greenhouse in Denver, Colorado: [82]

---

[77] *Id.*, Tr. at 13.
[78] *Id.*
[79] Scott F. Keller, "Retrofitting Warehouses", *Solar Age*, September 1978, pp. 28–30.
[80] *Passive Solar Hearings, supra* note, Tr. at 15.
[81] *Id.*
[82] *Id.*, Tr. at 17–18.



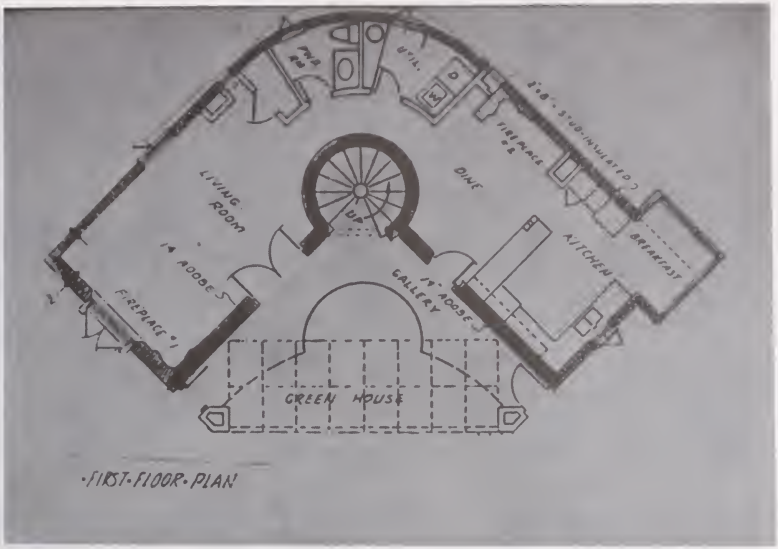
Built-in greenhouses or atriums can provide very significant solar fractions. Dr. Balcomb's home in Santa Fe, New Mexico, was discussed in the introduction to this report: [83]

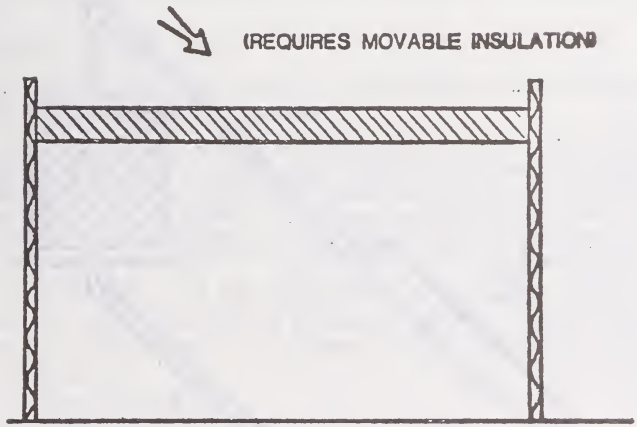
He heated his home last winter for 38 dollars in electricity bills and the cost of half a cord of firewood. He also reports substantial benefits from being able to grow vegetables and flowers indoors.

The fourth concept is the thermal storage roof or roof pond.[84]

Storage of solar energy is in containers of water located in the roof. Movable insulation opens to expose this storage mass to daytime sun but closes to retain the captured heat during the evening. Radiant heat is transferred through the ceiling into the living space.

[83] *Id.*, Tr. at 17.
[84] *Id.*, at 19–21.





By reversing the times the insulating panels are open, this system can be used for cooling in climates where dehumidification is not required. Opened to the evening chill, the mass is itself cooled. If the insulation is closed during the day, the stored coolness will help cool the home.

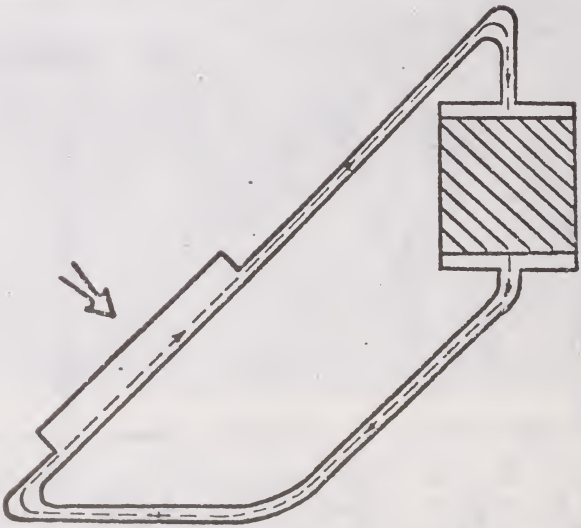
This concept has been popularized by this home in California.[85]

While it does require movable insulation, the system is reportedly quite effective.[86]

The final type of system is the convective loop or indirect thermosyphon.[87]

---

[85] *Id.*
[86] *Id.*
[87] *Id.*, Tr. at 21.



The collection area is placed below the storage mass so heat can be transferred without the need for mechanical assistance.

An example of this approach is provided by this home in Albuquerque, New Mexico.[88]

[88] *Id.*, Tr. at 21–22.

Rock bed storage is provided under the porch behind and above the collectors.

C. The costs of passive solar

According to a study prepared by the Office of Technology Assessment (OTA) for the Subcommittee: [89]

> the cost of heat from commercially installed passive solar heating systems ranges from $6.50–$16.50 per million Btu and is as low as $2.00 per million Btu if based only on the cost of new materials for owner-installed systems. This compares with present costs of $4.80–$16.00 per million Btu for typical furnaces, baseboard heaters, or heat pumps using gas, oil, or electricity. It thus appears that passive solar heating can be competitive with conventional home heating today.

Expressed in terms of the additional cost to the consumer for a passive system over the cost of normal wall per square foot of solar collection area, the systems discussed in the previous section break down as follows: [90]

Direct gain, $2 to $13;
Mass storage wall (Trombe Wall), $8 to $18;
Attached sun space, $5 to $15;
Thermal storage roof, $10 to $25; and
Convective loop, $5 to $8.

Recognizing that a number of engineering judgments are required, the Subcommittee asked OTA to provide estimates of the costs of various specific passive solar installations to assess the actual costs of this technology. These estimates are provided in Table 1.

---

[89] *Id.*, Tr. at 32.
[90] *Id.*, Tr. at 49.

TABLE 1

COST AND PERFORMANCE FOR SEVERAL PASSIVE SOLAR HEATING INSTALLATIONS

Installation	% Solar Heating	Incremental Cost of Passive System (Total Cost in $)	Incremental Cost of Passive System ($/ft^2 of glazing)	Heat Supplied to House (millions of Btus)	Cost of Heat* ($/Million Btu)	System Description
Lasar House New Milford, Conn.	70	2,000-3,000	4.00-6.00			200ft^2 direct gain, 175 ft^2 Trombe wall and 125 ft^2 greenhouse
Crosley House Royal Oak, Md.	50-60	2,500	7.15	38	6.50	200 ft^2 Trombe wall and 150 ft^2 direct gain
Kelbaugh House Princeton, N.J.	75-80	9,000	11.25	88	10.20	535 ft^2 Trombe wall, 200 ft^2 greenhouse and 65 ft^2 direct gain
Balcomb House Santa Fe, N.M.	80+	6,900	16.90	80	8.60	409 ft^2 greenhouse and rock-bed storage
1st Village #3 Santa Fe, N.M.		7,148	17.50	80	8.90	179 ft^2 Trombe wall, 144 ft^2 direct gain and 86 ft^2 greenhouse
1st Village #4 Santa Fe, N.E.		9,969	23.00	86	11.60	246 ft^2 direct gain and 188 ft^2 Trombe wall
Benedictine Monastery Pecos, N.M.	95	8,500	6.30			920 ft^2 direct gain and 426 ft^2 drumwall
Hunn House Los Alamos, N.M.	60	5,436	12.40	32.4	16.80	300 ft^2 Trombe wall and 140 ft^2 direct gain with rock-bed storage
Hay House Atascadero, Ca.	100	7,530	6.85			1100 ft^2 roof pond provides all heating and cooling

TABLE 1 Continued

Installation	% Solar Heating	Incremental Materials Cost of a Passive System (Total Cost in $)	Incremental Materials Cost of a Passive System ($/ft^2 of glazing)	Heat Supplied to House (millions of Btus)	Cost of Heat* ($/Million Btu)	System Description
RETROFIT GREENHOUSES						
Egri House Taos, N.M.	80	1,500	9.40	20	7.50	160 ft^2 greenhouse retrofit to adobe house
Solar Sustenance Project		395-652	2.40- 4.00	15-20	2.00- 4.30	Cost range for 12 retrofit greenhouses built throughout the Southwe
Griffin House Santa Fe, N.M.	24	127	0.50	22	0.58	Retrofit Greenhouse built largely from recycled materials

*Cost of Heat is computed assuming a 10% annual capital charge

Note: This table is based on material from the following sources:

Office of Technology Assessment, "Application of Solar Technology to Today's Energy Needs", July, 1977 (prepublication draft) and June, 1978 (final).

William A. Shurcliff, Solar Heated Buildings of North America: 120 Outstanding Examples, Brick House Publishing Co., Harrisville, New Hampshire 03450, 1978.

R. P. Stromberg and S. O. Woodall, "Passive Solar Buildings: A Compilation of Data and Results", Sandia Laboratories SAND77-1204, August, 1977.

John Hayes and Drew Gillett, editors, "Proceedings of the Conference on Energy-Conserving Solar-Heated Greenhouses", Marlboro College, Marlboro, Vt. 05344, November 19-20, 1977.

Andrew M. Shapiro, "The Crosley's House", Solar Age, November, 1977, p. 31.

Steve Lasar, private communication.

Bruce Hunn, private communication.

Wayne Nichols, private communication.

Table 2 estimates the costs of heat *delivered* to the home using various non-solar energy sources and technologies.

TABLE 2

COST OF HEAT SUPPLIED TO HOUSES FROM
FOSSIL FUELS AND ELECTRICITY

	Residential Fuel Prices ($/Million Btu)	Cost of Heat Supplied to Houses ($/Million Btu)	Cost of Heat Supplied to H Using Improved Equipmen ($/Million Btu)
Natural Gas	2.00- 4.00	4.80- 8.10	4.40- 6.90
Intrastate Gas	2.50- 4.00	5.60- 8.10	5.00- 6.90
Synthetic Gas --projection cited most often	4.00- 8.00 5.00	8.10-14.80 9.80	6.90-11.90 8.20
LNG	3.00- 6.10	6.50-11.60	5.70- 9.50
Natural gas from "exotic" sources (Tight formations, Devonian shale, geopressured aquifers)	3.25- 7.50	6.90-14.00	6.00-11.30
Oil (@50¢/gallon)	3.60	9.50	8.00
Baseboard electric heaters -electricity @3-5¢/kWh -electricity @ marginal cost of 7¢/kWh	8.79-14.65 20.51	10.10-16.00 21.80	NA NA
Heat pumps -electricity @ 3-5¢/kWh -electricity @ marginal cost of 7¢/kWh	8.79-14.65 20.51	8.30-12.10 15.80	7.00- 9.90 12.90

Passive solar is very competitive with electric resistance heat. Passive solar is marginally competitive with regulated gas. And it is the clearly superior choice if the comparison is with synthetic gas or other "new" sources of energy supply.

D. The information gap

An important threshold problem for most consumers is a lack of information about passive solar technology. Few consumers are generally aware of the technology and its potential. For those few who seek out passive solar systems, only a small number of suppliers, builders or architects are available who have the expertise to meet their needs.

In large part, this problem will be solved only if the Federal government assumes a different posture toward commercialization of this technology. As suggested by Dr. Hirshberg of Booz, Allen, & Hamilton:[91]

> [T]he Federal Government has traditionally focused only on research and development and not particularly on commercialization. The notion I think had been that once you developed a better mouse trap, the world would beat a path to your doorstep. I think there are a number of specific instances where that has proved to be false, and these small but very useful technologies, such as solar passive and active water heating and inexpensive active space heating, are good examples of that.

Since passive solar is principally a way of designing buildings, a program which effectively gets this technology out to consumers must deal with "the wide variety of players in the building industry process."[92] Three such "players" are particularly significant: the small contractor, local governments and the consumer himself.

Small contractors construct 70 to 90 percent of the homes and structures which are most suited for passive solar.[93] Typically, these builders do not use architects to design their products, even if they are large tracts. Plan books povide basic designs which are varied to meet local needs. Unless a structure is being custom built for a particular buyer, financial pressures force the small builder to sell his product as quickly as possible. In the words of Dr. Hirshberg: "Once his project starts, the meter is ticking, he doesn't want to fool around with anything new, anything different."[94]

These realities suggest the elements of a passive solar commercialization program directed at small builders. First, passive solar plans analogous to those in plan books should be made available to the small builder. Validated, simple design tools or rules-of-thumb would also be useful. Second, the builder must be substantially assured that a structure containing passive elements can be sold. Consumer information programs and commercial demonstations of the technology can address this problem.

Federal programs appear to be moving in these directions.[95] An initiative which speaks to both of these problems is a design competition for passive solar structures. HUD's passive solar design competi-

---

[91] *Id.*, Tr. at 76.
[92] *Id.*, Tr. at 77.
[93] *Id.*
[94] *Id.*, Tr. at 77.
[95] Frederick H. Morse and Michael Maybaum. "Commercialization Strategy Report for Passive Solar Heating," U.S. Department of Energy.

tion makes dollar awards for designs with the amount increasing if the design is actually built.[96] This mechanism will generate both designs and demonstrations. A reasonable next step would be to target such competitions on particular parts of the country and types of structures. Tract housing, the houses most of us buy, is a particularly appropriate focus for these programs.

A special competition or other incentive for the development of easily applicable retrofit systems could provide significant benefits. According to Dr. Hirshberg: "there needs to be more research and development in terms of justifying those kinds of [retrofit] designs from a technical point of view and then looking at the chain in which those designs might get out there in the market place and utilized." [97]

Demonstrations of the technology to the glass and masonry industries would also be extremely useful. These industries have generally been considered losers in the search for energy efficient building materials and designs. In fact, these materials coupled with appropriate passive designs can make them substantial winners.[98]

Local government is a traditional and most important "player" in the building industry. For passive solar consumers increased local government expertise would pay large dividends. Proper orientation with its attendant savings in energy could be mandated at the local level. Local building authorities can also act to provide "solar easements" which would guarantee that a solar system is not blocked from the sun through the construction of a high building or the planting of a tree. To deal with these problems, the Federal government can appropriately provide information and technical expertise to states and local governments.

Finally, the importance of informing the consumer about passive solar cannot be understated. Professor Balcomb estimates that nearly 10 percent of all the solar homes in the U.S. are in New Mexico, a state where the potential of solar energy has been relatively well-known for some time and where a tax credit has been in place for nearly three years. In Taos, a community of about 30,000 people, Professor Balcomb reports that about a quarter of all new homes built since 1975 are solar.[99]

A problem which confronts those trying to design an effective Federal passive solar program is the inability to seek important information on the needs and interests of those involved in the solar market. Dr. Hirshberg argued strongly that we need a "federal intelligence gathering mechanism in place, so that we can on an ongoing way understand what is actually happening in the marketplace [in order to] continually improve and upgrade federal proposals to take into account what is happening out there." [100] The Office of Management and Budget (OMB) places significant limitations on acquiring this needed information.[101] At least with respect to noncompulsory questionnaires, the Subcommittee believes these OMB limitations should be substantially lifted.

---

[96] "Passive Residential Design Competition and Demonstration," U.S. Dept. of Housing and Urban Development, Request for Grant Application H–8600, May 15, 1978.
[97] *Passive Solar Hearings, supra* note 3, Tr. at 77–78.
[98] *Id.*, Tr. at 83–84.
[99] *Id.*, Tr. at 84.
[100] *Id.*, Prepared Statement of Dr. Hirshberg.
[101] *Id.*, Tr. at 61–62. *See also* comments of Dr. Yarosh in a similar vein in Active Solar Hearing at 87.

E. The need for Federal incentives

The lack of replacement cost pricing for fossil fuels and electricity appears to be a significant limitation on solar development. The problem is that while passive solar is a very good buy for society when compared to the cost of many other "new" energy sources, the replacement cost of energy, it is only marginally competitive against the prices most consumers actually pay. As a consequence, what appears to be the best mix of passive solar and fossil fuel expenditures from the perspective of an individual consumer, may not be a good buy for society.

This can be illustrated by reviewing the following tables which compare the economic performance of a Trombe wall against heat provided by natural gas, home heating oil, and electricity. These tables were provided the Subcommittee by Professor Noll during his testimony and are based on work done at the University of New Mexico and the Los Alamos Scientific Laboratory.[102]

Each table indicates that a consumer who wishes to minimize his expenditures for heat would use some passive solar. The optimum percentage (or solar fraction) which minimizes total heating costs rises as the price of alternative energy rises. Thus a consumer in Madison, Wisconsin, would have passive solar supply 20 percent of his heating needs if his alternative is natural gas. But if the alternative is higher priced fuel oil or electric resistance heat, the optimum solar fraction would be 45 percent.

---

[102] *Id.*, Prepared Statement of Professor Noll at 47–54.

36-734 O - 79 - 5

ECONOMIC PERFORMANCE OF PASSIVE SOLAR RESIDENTIAL HEATING TROMBE WALL

ELECTRIC RESISTANCE FUEL ALTERNATIVE

	YEAR	SOLAR FRACTION	AREA	TOTAL COST	YIELD MMBTU/YR	$ MMBTU/YR	DELIVERED HEAT COST $/MMBTU	CONVENTIONAL COST $/MMBTU	SIMPLE PAYBACK TIME	YEARS TO POSITIVE SAVINGS	$ NET PRESENT VALUE
LOS ANGELES, CA	1978	.65	134	1747	18.1	96	8.18	11.83	8	0	2098
ATLANTA, GA	1978	.55	241	2508	22.0	114	9.54	12.22	9	0	2302
BOSTON, MA	1978	.50	397	4841	38.0	127	11.47	14.74	8	0	5212
ALBUQUERQUE, NM	1978	.65	314	3466	38.2	91	7.73	11.21	8	0	4222
CLEVELAND, OH	1978	.35	307	3970	30.0	132	11.46	13.04	10	0	3021
MEDFORD, OR	1978	.30	145	1815	19.1	95	7.28	7.79	12	0	831
MADISON, WI	1978	.45	422	4617	47.8	97	8.99	11.26	8	0	5032

los alamos
scientific laboratory
of the University of California

ECONOMIC PERFORMANCE OF PASSIVE SOLAR RESIDENTIAL HEATING TROMBE WALL

HEATING OIL FUEL ALTERNATIVE

	YEAR	SOLAR FRACTION	AREA	TOTAL COST	YIELD MMBTU/YR	$ MMBTU/YR	DELIVERED HEAT COST $/MMBTU	CONVENTIONAL COST $/MMBTU	SIMPLE PAYBACK TIME	YEARS TO POSITIVE SAVINGS	$ NET PRESENT VALUE
LOS ANGELES, CA	1978	.60	116	1521	16.7	91	7.32	9.49	12	0	1313
ATLANTA, GA	1978	.45	182	1898	18.0	105	8.17	9.30	14	0	1079
BOSTON, MA	1978	.40	287	3502	30.4	115	8.73	9.61	14	2	1694
ALBUQUERQUE, NM	1978	.55	237	2615	32.3	81	7.03	9.26	11	0	2745
CLEVELAND, OH	1978	.20	152	1963	34.3	77	8.68	9.01	15	4	776
MEDFORD, OR	1978	.40	214	2680	25.5	105	8.40	9.49	14	0	1634
MADISON, WI	1978	.45	422	4617	47.8	97	7.75	9.01	13	0	3055

los alamos
scientific laboratory
of the university of california

ECONOMIC PERFORMANCE OF PASSIVE SOLAR RESIDENTIAL HEATING TROMBE WALL

NATURAL GAS FUEL ALTERNATIVE

	YEAR	SOLAR FRACTION	AREA	TOTAL COST	YIELD MMBTU/YR	$ MMBTU/YR	DELIVERED HEAT COST $/MMBTU	CONVENTIONAL COST $/MMBTU	SIMPLE PAYBACK TIME	YEARS TO POSITIVE SAVINGS	$ NET PRESENT VALUE
LOS ANGELES, CA	1978	.10	14	180	2.8	64	4.21	4.22	19	12	27
ATLANTA, GA	1982	.10	31	326	4.0	82	5.41	5.42	18	12	56
BOSTON, MA	1978	.30	201	2457	22.8	108	7.70	8.03	17	9	783
ALBUQUERQUE, NM	1978	.10	34	371	5.9	63	4.10	4.11	19	12	53
CLEVELAND, OH	1984	.10	68	873	8.6	102	6.81	6.83	18	11	158
MEDFORD, OR	1978	.25	115	1443	15.9	91	6.80	7.12	17	8	571
MADISON, WI	1978	.20	147	1606	21.2	76	5.67	5.87	17	9	601

los alamos
scientific laboratory
of the University of California

According to Professor Noll, the heating oil alternative most accurately reflects the trade-offs which would exist if fossil fuels were priced at replacement levels. So that if energy were priced to reflect what it costs the American economy to acquire a new increment of energy, a home in Los Angeles would be 60 percent passively heated; in Boston, 40 percent; and in Cleveland, 20 percent.

But consumers generally do not make trade-offs among energy sources on the basis of the replacement cost of energy. Domestic price controls coupled with the rolling-in of expensive new sources of fossil energy with old sources present consumers with prices which are below replacement levels. As a result, they buy more fossil energy and less solar than they should.

Two solutions are possible: increase alternative energy prices to replacement levels or decrease the price of solar systems through the provision of government financial incentives to passive solar consumers. The first alternative has been properly rejected by the Congress as unfair to consumers; the second has been pursued with active systems but not for passive solar.

The recently enacted Energy Tax Act of 1978, P.L. 95–618, provides a substantial tax credit for the purchase of "renewable energy source equipment." A credit of 30 percent is provided for the first $2,000 and 20 percent for the next $8,000 of qualifying expenditures, for a maximum credit of $2,200. This key credit is not extended to expenditures "which will serve a significant structural function in the dwelling." [103] According to Dr. Balcomb, taken literally this would "largely exclude passive systems except for a few designs." [104]

In the Subcommittee's judgment, this limitation substantially and inappropriately discriminates against passive systems. Passive systems are generally more cost effective for space heating purposes.[105] To the extent consumers are influenced by credits they may be directed toward less cost effective technologies. As suggested by Congressman Gore: [106]

> It appears in summary that we give tax incentives to the least cost effective forms of solar energy (for heating and cooling) and we deny tax incentives to the most cost effective form of solar energy.

The Subcommittee believes this discrimination should be eliminated.

A problem which faces the provision of a credit is properly defining what is eligible for the credit. Such a definition must be as inclusive as possible without opening up the Federal treasury for any and all home improvements. This is a difficult problem. But both California and New Mexico have been able to meet this challenge in the provision of state credits. In California, the eligibility criteria for passive solar provides a highly detailed guide to the technology itself. In New Mexico, individual plans are reviewed for their adequacy so the stated criteria are somewhat simpler than those used by California. Whatever the approach, this problem can and must be dealt with.

Tax credits may not be the only effective way to provide proper economic signals to consumers. Because a passive solar system is an

---

[103] Conference Report on H.R. 5263, Energy Production and Conservation Tax Incentive Act. Cong. Rec. October 12, 1978, Pt. II, at H–12552–51.
[104] *Passive Solar Hearings*, *supra* note 3, Tr. at 30.
[105] *Id.*, Tr. at 30.
[106] *See* note 4.

integral part of a building, provision of passive solar incentives through new mortgage instruments may be even more effective than tax credits. According to Professor Noll, tax credits and low interest loans could be "in terms of the economics . . . identical" but the psychology may be "different for the two programs." [107]

Providing a solar subsidy through a low interest loan could be potentially more effective than a tax credit. When making a judgment on whether to buy a home, consumers generally give great weight to the cost of mortgage money. If that cost is decreased if a passive system is installed, consumers may respond faster to such an incentive than a tax credit. In any case, an individual consumer should not be given both an interest subsidy and a tax credit.

A graduated mortgage payment system by which interest payments are low at the beginning and rise over time could also offer substantial benefits. A passive system could be installed on a new home and the cost of the system borne over time. As indicated by Congressman Gore "the long-term savings of utility costs would enable homeowners to keep up with the accelerated principal payments." [108] This matching of the timing of the occurrence of benefits and costs is very attractive. The Subcommittee believes that special consideration should be given to such innovative mortgage instruments in the development of appropriate financial incentives for passive solar.

---

[107] *Passive Solar Hearings, supra* note 3, Tr. at 73.
[108] *Id.*, Tr. at 73–74.

Chapter 6.—The Federal Government and the Solar Consumer

A. Overview

This report has identified a number of specific problems confronting the potential solar consumer. Consumer protections mechanisms need to be substantially strengthened to protect the active solar consumer. Steps must be taken to give consumers effective access to simple passive solar technology.

The Subcommittee would like to be able to conclude that the Federal government is rapidly moving ahead with policies and programs to address these matters. To some degree, Federal agencies are coming to grips with these issues. But emerging overall Federal policy appears to be uncertain with respect to these problems. Equally disturbing are the organizational problems which will stymie the implementation of any solar policy.

B. Policy direction

Federal solar policy is in transition. After years of neglect, solar energy is the recipient of a large and growing amount of Federal largesse. According to *Business Week*, Secretary of Energy Schlesinger will ask for nearly a billion dollars for solar research and development in Fiscal Year 1980.[109]

At stake in the use of these funds and the Federal dollars which will doubtlessly follow is the magnitude of the contribution solar can make to U.S. energy supply. The range of possibility is wide. The Council on Environmental Quality concluded in April 1978 that with serious energy conservation and acceleration of solar development, a quarter of the Nation's energy needs, or between 20 and 30 quads (quadrillion Btu's) could be provided by solar in the year 2000.[110] Estimates prepared for the President's Domestic Policy Review of solar range from a low a 9.4 quads to 28.1 quads by the year 2000.[111] Leading solar author Dennis Hayes estimates that 25 quads is an achievable goal.[112] These studies acknowledge that even very modest solar contributions to U.S. energy supply can be achieved only if sufficient attention is given the practical questions of how to establish the needed design, fabrication, installation and financial infrastructure of the solar industry.

How this Nation will deal with these practical issues is expected to be substantially determined by the Domestic Policy Review announced by President Carter on Sun Day, May 3, 1978. Premised upon the expressed interest of the President in making maximum economic use of solar energy, the list of recommendations contained in the Domestic Policy Review (DPR) are expected to set the Nation's solar agenda.

---

[109] "The Coming Boom in Solar Energy", *Business Week*, October 9, 1978.
[110] "Solar Energy, Progress and Promise," Council on Environmental Quality, Washington, D.C., April 1978.
[111] *National Journal*, September 23, 1978, p. 154.
[112] As quoted in the *National Journal*, Sept. 23, 1978, p. 154.

While as yet only available to the public in the form of a not yet final "Public Review Copy", the document has already become a *cause celebre*. Amory Lovins, a leading "soft" technology theorist, concluded that it was "a largely vacuous and uncreative exercise in ducking the big issues".[113] While Mr. Lovins' comment may be considered somewhat uncharitable, the DPR does show considerable adroitness in avoiding specific policy recommendations.

With respect to consumer protection, the DPR opines that "widespread public confidence is a critical factor for increasing solar energy use." [114] Indeed true, but the DPR goes little further than this in its review of consumer protection mechanisms. In the key area of solar warranties, the DPR merely notes that "An important issue is whether the benefits of warranties to consumers outweigh the possible benefits they (sic) place on the industry." [115]

This treatment of consumer protection issues is clearly inadequate. The Federal government is pouring money into tax credits and grants to induce consumers to buy solar systems. Such actions impose upon the Federal government a responsibility to help assure that an individual consumer gets a system which is safe, reliable and worth the money. If such assurance is not provided, we run the risk that solar will be discredited and abandoned as a serious energy option by consumers much as heat pumps were abandoned in the 1950's.

With respect to actions on behalf of simple, relatively low cost technologies like passive solar, the Report notes that in the expenditure of $160 million for solar demonstrations "key program issues are the balance between systems development and systems demonstrations, particularly of current, relatively high-cost systems." [116] Neither the issues nor the facts behind the statement are discussed. But apparently the issue which the DPR is seeking to avoid is that Federal research development and demonstration subsidies have tended to go to more complex and less economically feasible solar systems. This is a central problem with the current Federal program and was much discussed by citizens and organizations providing input to the DPR.[117] A recent study funded by the Department of Energy itself found that U.S. solar research and development programs underemphasize technologies like passive solar.[118] Against this background, it is disquieting to see an important question essentially avoided.

The DPR is not yet final. It is the hope of the Subcommittee that the final version sent to the President will squarely address the problems of consumer protection and the need to have Federal programs meet the needs of the potential passive solar consumer. If it does not, the public may agree with Amory Lovins that the drafters should "start over".[119]

---

[113] A copy of Lovins' analysis is available in Subcommittee files. For a summary, *see Energy Daily*, Sept. 21, 1978.

[114] "Status Report on Solar Energy", Domestic Policy Review, Public Review Copy, Aug. 25, 1978, IV–19.

[115] *Id.*

[116] *Id.* at IV–3.

[117] *See*, for example, remarks of James W. Benson of the Council of Economic Priorities of New York and Jerry Plunkett of the Montana Energy Research and Development Institute, at the July 13, 1978, DPR meeting in Washington, D.C. summarized in Consumer Briefing Summary No. 7, prepared by the Office of Public Affairs, Department of Energy.

[118] "A Comparative Evaluation of Solar Alternatives: Implications for Federal RD & D," SRI International, January 1978. *See also* Douglas Balcomb, "The DOE Solar Program: A Question of Balance," *"Solar Age*, May 1978.

[119] *Supra* note 113.

C. The need for coordination

The task of organizing the Federal solar bureaucracy and establishing meaningful coordination with regional, state and local agencies has hardly begun. This would be a major challenge under any circumstances but the current structure of the Federal solar program imposes added burdens.

The National Solar Energy Research Institute, which has been designated as DOE's lead institution with respect to solar research, is managed by the Assistant Secretary for Energy Technology, while the four regional solar centers, which have the primary mission of commercialization and integral conservation activities, and work with states and local governments, come under the Assistant Secretary for Conservation and Solar Applications. Coordination between DOE Washington and the states generally is handled by the Assistant Secretary for Institutional and Intergovernmental Affairs. Consumer protection generally is handled by the Office of Consumer Affairs and specific solar consumer protection is spread throughout Solar Applications. The Deputy Under Secretary for Commercialization is also involved in several solar commercialization efforts.

Actual management of the large majority of existing demonstration programs is handled for DOE by HUD. Other federal bodies engaged in solar research and development include the Departments of Agriculture and Interior, the Environmental Protection Agency, and the Tennessee Valley Authority. The Department of Defense is included in solar demonstration programs. Financial and loan programs that relate directly or potentially to solar are administered by HUD, the Departments of Commerce and Agriculture, the Small Business Administration, the Community Services Administration, the Veterans Administration, the Government National Mortgage Association, the National Mortgage Association, and the Federal Home Loan Mortgage Corporation. Looking ahead, the National Energy Act contains several additional solar tax, loan, grant, and conservation programs that will need to be integrated with existing programs. At some point, so will the energy extension service.

Finally, the Treasury Department through the Internal Revenue Service will administer the tax incentive programs. The relationship of IRS to DOE and HUD in carrying out these critical programs is still emerging.

The feeling of frustration and confusion as to who is doing what was aptly summarized at the Washington DPR meeting by David Morris of the Institute for Local Self-Reliance: [120]

> In doing the investigation for this presentation, I was struck by the number of people in local government, state government, and in the Department of Energy who told me that they long since have thrown up their hands at trying to figure out who had responsibility for what within the solar bureaucracy.

Such a situation does not bode well for solar. Federal managers must take steps to clarify and rationalize solar program structures. In the near term, a hotline or other single source of information would be useful to guide consumers, local and state representatives, and industry through the current maze of solar programs.

---

[120] Department of Energy, Office of Public Affairs, Consumer Briefing Summary No. 7.

APPENDICES

A. "Summary of New England Electric Solar Water Heating Equipment", Subcommittee Staff Memorandum, September 18, 1978.
B. "Summary of Florida Solar Energy Center Survey of Solar Consumer Problems", Subcommittee Staff Memorandum, September 15, 1978, plus attachments.
C. "Summary of Problems in DOE-Funded Solar Energy Systems", Subcommitee Staff Memorandum, September 18, 1978.
D. Results of Subcommittee Questionnaire.
E. Graphic displays of certain key findings of the Subcommittee questionnaire.

APPENDIX A

NINETY-FIFTH CONGRESS

JOHN E. MOSS, CALIF., CHAIRMAN

JIM SANTINI, NEV.
THOMAS A. LUKEN, OHIO
DOUG WALGREN, PA.
ALBERT GORE, JR., TENN.
CHARLES J. CARNEY, OHIO
HENRY A. WAXMAN, CALIF.
PHILLIP R. SHARP, IND.
THOMAS TOBY MOFFETT, CONN.
DREW MAGUIRE, N.J.
ROBERT (BOB) KRUEGER, TEX.

HARLEY O. STAGGERS, W. VA.
(EX OFFICIO)

JAMES M. COLLINS, TEX.
NORMAN F. LENT, N.Y.
MATTHEW J. RINALDO, N.J.
DAVE STOCKMAN, MICH.
MARC L. MARKS, PA.
SAMUEL L. DEVINE, OHIO
(EX OFFICIO)

CONGRESS OF THE UNITED STATES
HOUSE OF REPRESENTATIVES
SUBCOMMITTEE ON OVERSIGHT AND INVESTIGATIONS
OF THE
COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE
WASHINGTON, D.C. 20515

ROOM 2323
RAYBURN HOUSE OFFICE BUILDING
PHONE (202) 225-4441

JAMES L. MCLAUGHLIN
OPERATIONS DIRECTOR

JOHN M. CLEARY ATTORNEY
COUNSEL TO THE SUBCOMMITTEE

TASK FORCE DIRECTORS
LOWELL DODGE—OVERSIGHT
JOHN R. GALLOWAY—ENERGY
ELLIOT A. BEGAL—HEALTH

J. THOMAS SCHEDE
COUNSEL TO THE CHAIRMAN

BERNARD J. WUNDER
MINORITY COUNSEL

MEMORANDUM

DATE: September 18, 1978

TO: John E. Moss, Chairman

FROM: Subcommittee Staff

SUBJECT: Summary of New England Electric Solar Water Heating Experiment

Introduction

The New England Electric System began a solar water heating experiment in September 1975 to test the performance of commercially available solar water heaters. The utility wanted to see if solar hot water heating could aid in leveling peak electric power demand. By December 1976, nearly all of the 100 test units were installed in single family homes in Massachusetts, Rhode Island, and New Hampshire.

Results

According to an October 1977 study of the experiment prepared by Robert O. Smith and Associates, a professional engineering firm from Newton, Massachusetts, "results are still undetermined about demand peak effects because so much difficulty was encountered in the mechanical functioning of the solar water heaters."

Specifically, the 100 installations functioned as follows:

I. Successful Systems

Functioned Well	No Serious Breakdowns
15	23 (includes best 15)

II. Unsuccessful Systems

At Least One Major Stoppage Requiring Technicians to Repair	Severely Interrupted and Unreliable Service	Very Low or No Savings
77	20 (included in the 77)	27 (included in the 77)

Overall average energy savings were under 20 percent. The best 15 systems reduced water heating energy consumption by an average of 37 percent in a severe winter, and the worst 15 systems averaged less than five percent savings. The budget, originally set at $250,000, nearly doubled. However, some systems were made to work well after major modifications.

According to the consulting engineers:

> "Most of the troubles encountered in this project are due mainly to flaws in installation, secondarily to flaws in the selection of component sizes and types, (and) thirdly to lack of inspections and adjustments which are necessary after installation. Some problems can be associated with generic type of system..."

Conclusion

According to a report prepared for the New England Electric System by Arthur D. Little, Inc., the experiment suffered from "unreasonably high expectations." The report went on to observe that:

> "The issue of high expectations is particularly relevant because of the government grant and incentive programs currently being established. Consumer frustration could impede the development of the solar market unless particular efforts are made to insure that systems installed with government or industry support address many of the difficulties encountered in this program. In addition, consumers must be cautioned in advance about the operating problems associated with these early installations."

REPORT
SUMMARY OF PERFORMANCE PROBLEMS OF 100 RESIDENTIAL SOLAR WATER HEATERS INSTALLED BY NEW ENGLAND ELECTRIC COMPANY SUBSIDIARIES IN 1976 AND 1977

PREPARED BY
ROBERT O. SMITH AND ASSOCIATES
PROFESSIONAL ENGINEERS

55 CHESTER ST
NEWTON HIGHLANDS, MASS.
02161

OCTOBER 1977

B.N.L. Contract No. 419 929-S

Prepared for the Solar Technology Transfer Program
at Brookhaven National Laboratory
and supported by the Solar Division
U.S. Department of Energy

TABLE IV-B TROUBLE ANALYSIS

CODE	TYPE OF TROUBLE	TOTAL COUNT OF SYSTEMS EXPERIENCING THIS ONE OR MORE TIMES	TYPES OF SYSTEMS AND COUNTS OF TROUBLES				
			Anti-frz.	Drain-back	Drain-out	Heated Pipe	Air
A -	GENERAL SYSTEM: TOTAL	69:	14	0	34	20	1
6	Water hammer noise	9	1		6	2	
8	Froze	30	1		19	10	
10	Very low economy (below 10%)	27	10		8	8	1
29	Water seepage into house	3	2		1		
B -	COLLECTORS: TOTAL	23:	10	0	6	7	0
1	Leak at known joint	9	2		2	5	
2	Leak, unspecified	5	1		2	2	
4	Burst pipe	1			1		
17	Outer cover cracked	1	1				
20	Damaged by wind	3	3				
23	Wrong insulation mat. or th.	1	1				
26	Buckled casing	1	1				
28	Inner cover broken, adrift	2	1		1		
C -	PIPING: TOTAL	60:	8	0	33	18	1
1	Leak at unknown joint	16	3		6	7	
2	Leak, unspecified place	5	2		3		
3	Draindown reservoir overflow	3			3		
6,33	Water hammer	1			1		
7	Not pitched properly	15			15		
9	Became airbound	14	1		3	10	
23	Wrong insulation mat or th.	6	2		2	1	1
D -	VALVING: TOTAL	21:	9	1	8	3	0
1	Leak at known place	3	2		1		
5	Frozen or stuck	5	1	1	3		
12	Relieved too often	3	3				
25	Fault in valve	4	2		2		
36	Omitted or mislocated	6	1		2	3	
	PAGE TOTALS	173	41	1	81	48	2

TABLE IV-B TROUBLE ANALYSIS, CONTINUED

CODE	TYPE OF TROUBLE	TOTAL	A.F.	D-B	D-O	HP	Air
E-	TANK, HT-EXCH, ELEC. HEATER	7:	6	0	1		0
1	Leak at known place	2	1		1		
2	Leak, unspecified place	1	1				
13	Failed elec. heating elem.	1	1				
14	Failed elec. heater thermostat	1	1				
16	Temp. control relay fault	2	2				
F-	PUMP OR BLOWER & MOTOR	20:	8	0	2	9	1
1	Leak in pump	2	2				
11	Motor malfunction	3	3				
22	Pump installed backwards	1	1				
24	Excessive noise	5	1		1	2	1
30	Pump didn't move water	2			1	1	
31	Overheated	7	1			6	
G-	TEMPERATURE SENSORS	7:	4	1	1	1	0
18	Fault in sensor	3	2	1			
35	Sensor became detached	4	2		1	1	
H-	CONTROLLER	33:	13	0	17	2	1
15	Ran continuously or cycled excessively	26	11		12	2	1
27	Wired backwards	2	1		1		
32	Freeze protection setting too low	3			3		
33	Settings not optimal or not in range	2	1		1		
I-	MISCELLANEOUS	1	1	0	0	0	0
	Antifreeze solution too weak	1	1				
	PAGE TOTALS, p. 2	68	32	1	21	12	2
	PAGE TOTALS, p. 1	173	41	1	81	48	2
	GRAND TOTALS	241	73	2	102	60	4
	PERCENTAGES	100%	30	1	42	25	2
	SYSTEM COUNT AND %	100	48	2	24	22	4

APPENDIX B

NINETY-FIFTH CONGRESS

JOHN E. MOSS, CALIF., CHAIRMAN

JIM SANTINI, NEV.
THOMAS A. LUKEN, OHIO
DOUG WALGREN, PA.
ALBERT GORE, JR., TENN.
CHARLES J. CARNEY, OHIO
HENRY A. WAXMAN, CALIF.
PHILIP R. SHARP, IND.
ANTHONY TOBY MOFFETT, CONN.
ANDREW MAGUIRE, N.J.
ROBERT (BOB) KRUEGER, TEX.

JAMES M. COLLINS, TEX.
NORMAN F. LENT, N.Y.
MATTHEW J. RINALDO, N.J.
DAVE STOCKMAN, MICH.
MARC L. MARKS, PA.
SAMUEL L. DEVINE, OHIO
(EX OFFICIO)

HARLEY O. STAGGERS, W. VA.
(EX OFFICIO)

CONGRESS OF THE UNITED STATES
HOUSE OF REPRESENTATIVES
SUBCOMMITTEE ON OVERSIGHT AND INVESTIGATIONS
OF THE
COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE
WASHINGTON, D.C. 20515

ROOM 2323
RAYBURN HOUSE OFFICE BUILDING
PHONE (202) 225-4441

JAMES L. WILLIAMS
OPERATIONS DIRECTOR

JOHN MC ELROY ATKINSON
COUNSEL TO THE SUBCOMMITTEE

TASK FORCE DIRECTORS
LOWELL DODGE—OVERSIGHT
JOHN B. GALLOWAY—ENERGY
ELLIOT A. SEGAL—HEALTH

J. THOMAS SIDEDINE
COUNSEL TO THE CHAIRMAN

BERNARD J. WUNDER
MINORITY COUNSEL

MEMORANDUM:

DATE: September 15, 1978

TO: Honorable John E. Moss, Chairman

FROM: Subcommittee Staff

SUBJECT: Summary of Florida Solar Energy Center Survey of Solar Consumer Problems

INTRODUCTION

The Florida Solar Energy Center (FSEC) has, under contract to DOE, identified a number of solar users in Florida and completed a preliminary survey as to the experiences of these solar consumers. The work was undertaken as part of an effort by elements in the DOE to develop a consumer protection package to support solar demonstrations and commercialization efforts. The experiences of some 522 solar users are described in a May 18, 1978, Letter Progress Report from the FSEC to the DOE. Attachment D to that letter presents the findings. The letter and the attachment are appended to this memorandum.

RESULTS

In general, solar consumers reported that they were satisfied with their systems:

Satisfied	Mixed	Unsatisfied
67%	21%	12%

However, a large number of the respondants reported problems in the operation of their solar systems:

Total Number of Owners Reporting Major and Minor Problems	Estimated Number of Owners With Major Problems
239 (46%)	22%

A major problem is defined as one which (a) costs more than 5% of the initial system cost to repair, or (b) took more than 15 days to correct, or (c) was greater than that experienced with equivalent systems using traditional energy sources.

A survey of 216 of the owners revealed that 111 reported that the problems with their solar systems had not been corrected yet. 111 represents 46% of all the problems reported.

An owner's satisfaction level was not a reliable indicator of whether or not the solar system had experienced problems. For example, 28 owners were satisfied despite the fact that their systems had frozen and 10 owners were satisfied even though their units had suffered sensor failure.

The FSEC survey found that most of the problems occurred soon after installation, and almost 80% within one year of purchase. While over 80% of the systems were installed in or after 1974; and over 50% in 1977 and 1978, about 15% were installed prior to 1960.

May 18, 1978

Ms. Lynda T. Connor
Governmental Technical Representative
Department of Energy
12th & Pennsylvania Avenues, NW, Room 1422
Washington, DC 20461

Dear Ms. Connor:

SUBJECT: LETTER PROGRESS REPORT #4
Development of Solar Energy Consumer Protection Systems
Cooperative Agreement EM-77-F-01-8140

In accordance with Cooperative Agreement EM-77-F-01-8140 between the Department of Energy and the State of Florida (Florida Solar Energy Center), attached is Letter Progress Report #4 on the subject project.

An invoice of costs incurred on the project is being forwarded to your office from the Division of Sponsored Research at Florida Technological University.

Sincerely yours,

Marvin M. Yarosh, Director
Energy Systems Analysis Division
Project Manager

MMY:kg

Attachment

FLORIDA SOLAR ENERGY CENTER
300 State Road 401, Cape Canaveral, Florida 32920 Telephone: 305/783-0300

May 18, 1978

Letter Progress Report #4

Cooperative Agreement EM-77-F-01-8140

Development of Solar Energy Consumer Protection Systems

Introduction

Since Letter Progress Report #3, we have made significant progress on the various tasks defined in the work plan. These are discussed below.

Summary of Activities and Results

Contact With Agencies (Federal, State, Local, Private) Related to the Project:

The response to our efforts in establishing contact with agencies with interests related to our project has been described in Appendix A of Letter Progress Report #3. About 20 complaints were received from these agencies, and an analysis of these complaints is attached as Appendix A to this report. These complaints have been in the area of misrepresentation of system performance and in the sale of franchises, distributorships and dealerships; improper installation; inadequate repair service; and the vendor going out of business.

Identification of Solar Consumers:

As described in Letter Progress Report #3, efforts in this task have been continuing. We have now identified over 1,000 solar users in Florida, and a preliminary breakdown of the sources for information on these owners is shown in Figure 1.

FIGURE 1: Solar Owners Identified in Florida
April 1978

Sources	
Better Business Bureaus/Chambers of Commerce	4
Department of Consumer Services	~15
Permits	0
National Solar Heating & Cooling Information Center	0
News Media/Advertisements/Mail-Ins	~80
Industry Supplied	~200
HUD Program	~120
Toll-Free Hot Line	~600
TOTAL:	~1,000

The techniques used in owner identification were described in Letter Progress Report #3. Substantial efforts to advertise the "hot line" were performed, and a brief description of typical efforts associated with advertisement of the hot line is attached as Appendix B to this report.

Analysis of the Problem:

The letter and postcard shown in Appendix D of Letter Progress Report #3 were mailed to all identified solar users. The letter inquired of the interest of the solar user in cooperating with us on the project, and only 3 out of all users identified expressed an unwillingness to share their experiences. The postcard instructed users to assess their experience and report it to us as "Satisfactory," "Unsatisfactory," or "Mixed." A tabulation of the responses received for 950 users is shown in Appendix C. The data of Appendix C represents the solar owner's own

assessment of his experience as Satisfactory, Unsatisfactory, or Mixed, and such an assessment is, of course, highly subjective. To obtain additional insight into the meaning of these terms, we performed a detailed analysis of the hot line data points and also in-depth telephone discussions with about 65 owners. These 65 users were selected from the pool of names that had already contacted the Center via the postcard.

All owners that called the Center on the hot line were asked a set of questions on the form attached as Appendix F to Letter Progress Report #3. Some 500 of the responses to these questions have now been analyzed, and the results are shown in Appendix D to this report. Approximately three out of every four solar owners calling the Center indicated they were satisfied with their solar experience.

The in-depth telephone discussions conducted were designed to probe and seek various pieces of information that would enable us to draw experience profiles of Satisfactory, Unsatisfactory, and Mixed solar users. In our categorization, we attempted to determine whether the owner had a significant problem. The findings are attached as Appendix E to this report.

We defined a significant problem as one which:

a. Cost more than 5 percent of the initial system cost to repair, or
b. Took more than 15 days to correct, or
c. Was greater than that experienced with equivalent systems using traditional energy sources.

We have been able to obtain the following profiles:

Typically,

an owner reporting his experience as Satisfactory has not had significant problems;
an owner reporting his experience as Unsatisfactory has had significant problems;
50% of the owners reporting their experience as Mixed have had significant problems.

Although there are exceptions to these profiles, they are relatively few, and our sample size was large enough to justify these profiles within reasonable errors.

To define the consumer problem, we need to assess both its magnitude and also the nature and causes of the problems. The data in Appendix C indicates that 12% of the owners have assessed their experience to be Unsatisfactory, and 21% assessed their experience to be Mixed. Using this data and the above profiles, we estimate that about 22% of solar users have had significant problems. This represents the magnitude of the consumer problem.

To understand the nature and causes of the consumer problem, reference is again made to Appendices D and E, which deal with the hot line data and the in-depth telephone discussions, respectively. To date, we have been able to identify 5 major problem areas. These are: .

- Installation Problems
- Inadequate System Performance
- Inadequate or Unsatisfactory Repair Service
- Unsatisfactory Information Provided By Vendor
- Unsatisfactory Redress Action

For each of these problem areas we have identified some typical problems encountered and suggested some causes. These are shown in Appendix F to this report. Our data suggests that if the owner's description of his problem and experience is correct, it is relatively easy to identify the nature of the problem; it is extremely difficult, however, to determine the cause of the problem. The difficulty is compounded by the fact that the discussions and probings have taken place over the telephone, and thus personal assessment of the solar system, the installation, and the information provided by the vendor has not been made. It is evident from Appendix F that an identified problem can stem from a number of deficiencies. Component failure, for example, may be a result of inadequate operating or maintenance instructions, or may result from poor system or component design. An assessment of the adequacy of instructions would require either personal inspection or more extensive questioning of the owner. Thus, without additional information, there remains uncertainty as to the exact cause of problems identified by our solar experience information.

We have determined that in order to gain certainty about the nature and causes of the consumer problem, we need to expand our 5 problem areas to include more specific ones and accurately assign a cause, or causes, to each. To accomplish this, an in-depth structured survey of the 1,000-plus owners identified needs to be performed, with possible field visits to establish confidence in the survey results. Unfortunately, the detailed survey and field visits are beyond the scope of this project.

Consumer Problems In Other Industries:

For comparative purposes, a search was initiated for information on studies and surveys in the heating, ventilation, and air conditioning industries which could yield consumer satisfaction levels with technologies analogous to solar, problems encountered with these technologies, and indicate industry interface with consumer protection mechanisms and systems. Industry associations, trade associations, manufacturing firms, research institutes, and other organizations were contacted for this information. This search proved disappointing for all industries except the heat pump industry. Relevant data concerning the heat pump experience is attached as Appendix G. On the whole, we have determined that there is a critical shortage of data available to the public pertaining to consumer experiences in other fields. Information surveys conducted by private firms on product performance and acceptance are treated as proprietary by the firms involved.

Solar System Contact Groups:

We have prepared a final draft of the task report identifying the contact groups for the solar consumer. The original scope of the work statement has been expanded here to include not only the industry contact groups (manufacturers, distributors, dealer/installers, architects/engineers, builder/developers, etc.), but also informational contact groups, such as industry advertisements, press reports, periodical and government information sources. These must be considered as part of the solar industry infrastructure in that they contribute to the consumer's decision, his expectations, and his ultimate satisfaction or dissatisfaction with solar energy systems. Additional details are provided in the task report—Appendix H. DOE is requested to carefully review Appendix H and return their comments within 10 days of receipt of this document.

Workshop:

Approximately 360 individuals were invited to the Solar Energy Consumer Protection Workshop in Atlanta, Georgia. After mailing of the Preliminary Announcement to these invitees, numerous telephone calls were made to specific individuals

in an attempt to get a balanced attendance, geographically and with respect to consumer organizations, industry representatives, government offices, state energy offices, public utilities, etc. There were 115 participants who attended the May 3-6 Workshop. The Preliminary Announcement, Final Agenda, and Guidelines for Workshop Chairmen and Discussion Leaders are attached as Appendices I, J, and K, respectively. Additionally, to provide the participants with the relevant background information on solar heating and cooling technology, a brief summary on the status of solar heating and cooling was also prepared. This is attached as Appendix L to this report.

We are presently awaiting receipt of the transcript of the proceedings of the Workshop. Further detailed analyses of the recommendations will be made after reviewing the transcripts. It was evident, however, from the final plenary session, that the participants were almost unanimous in their conclusion that new and alternative consumer protection mechanisms are not needed, but that existing consumer protection mechanisms should be utilized and made more effective. This may require enforcement and, where necessary, provision of adequate budgets to support such enforcement.

Consumer Protection Mechanisms:

For purposes of the Workshop discussion, we identified the 8 most important existing consumer protection mechanisms. These are: (1) Standards, Testing, Certification and Labeling; (2) Trade Licensing Laws and Training Programs; (3) Building Codes; (4) Consumer Education/Information; (5) Federal, State and Local Consumer Protection Laws; (6) Warranties; (7) Utility Regulation; and (8) Self-Regulation by Trade, Industry and Business Groups. Detailed descriptions of each of the 8 mechanisms were prepared, along with suggested criteria for evaluating the effectiveness of these mechanisms. (The Descriptions and Evaluation Criteria are attached as Appendix M.)

In addition, a brief description was prepared for each of the following consumer protection mechanisms: (1) Disclosure Statements; (2) Bonding; (3) Common Law Remedies; (4) Better Business Bureaus; (5) Consumer Action Panels; (6) Mediation—Arbitration; and (7) Information Dispute Settlement Mechanisms. (This is attached as Appendix N to this report.)

Progress With Respect to Work Plan and Upcoming Plans

We have completed a final draft for your review (attached as Appendix H) of the section on industry infrastructure and solar system contact groups.

We have gathered significant information on the magnitude of the consumer problem. Our data reflects owner assessments of the nature of the consumer problem, and from our knowledge and experience with solar systems and solar users, we have identified a range of possible causes associated with the problems identified. We have categorized those problems most frequently occurring and identified mechanisms which will address these problems.

We have held a nationally-attended, and successful, Consumer Protection Workshop in Atlanta and explored the mechanisms and issues involved in consumer protection and evaluated the effectiveness of existing consumer protection mechanisms. The transcripts of the Workshop will be available within 30 days and will be summarized in a future Letter Progress Report. Detailed proceedings of the Workshop are also planned.

In verbal discussions with the Technical Project Officer we have agreed that the strong concensus of the Workshop participants was that new consumer protection mechanisms are not required, or necessary. The project staff will therefore not attempt to develop new mechanisms. We agreed that present mechanisms which address different facets of the consumer problems experienced, in aggregate, constitute a consumer protection system. The system itself thus consists of mechanisms which may be integrated into the system, but which often are effective as a consumer protection mechanism independent of their application within a system. By putting together existing mechanisms in alternate structures, new or alternate consumer protection systems can be examined.

We will now examine the application and integration of existing mechanisms into consumer protection systems. We will determine if there appears to be gains made through systems of consumer protection over application of existing independent consumer protection mechanisms.

We will attempt to determine improved strategies for implementation of existing mechanisms and systems, and determine the costs and legal and administrative barriers to program implementation.

Potential Problems

We anticipate serious difficulty in assessing the true costs of implementing the strategies for more effective application of consumer protection mechanisms and systems. Such costs should include not only direct administrative costs of such programs, but also costs reflected in industry as a result of the programs and how such programs affect solar equipment costs. We must also assess the impact on both solar market and solar industry development.

(FOR REVIEW ONLY)

FSEC Toll-Free Telephone Line

Results to Date

Steven R. Sim

Present date: April 21, 1978

Begginning date: January 11, 1978

(The total number of days the phone has been in operation is 73. The phone operates from 9 a.m. to 6 p.m., Monday through Friday.)

Results to Date

(A) Number of Calls Received and Owners Located:

Total number of calls received:	910
Total number of solar owners identified:	522
Percentage of total calls which come from owners:	57%

Comment:

All efforts to publicize the toll-free line have stressed that the line is for the sole purpose of allowing solar owners to call the Center and inform us of their experiences with their solar equipment. This type of publicity has greatly increased FSEC's ability to attract only solar unit owners to use the line. By comparison, the National Solar Heating and Cooling Information Center's (NSHCIC) toll-free phone line is advertised as an informational line. The NSHCIC estimates that only 10% of their calls come from solar equipment owners.

(B) System Application (by the total number and percentage):

Residential:	506	(97%)
Commercial:	16	(3%)

Domestic Hot Water (DHW)	:	420 (80%)
Pool Heating (PH)	:	49 (9%)
DHW & PH	:	25 (5%)
Space heating (& DHW)	:	13 (2%)
Space cooling (& space heating & DWH)	:	14 (3%)
Other	:	1 (less than 1%)

Comments:

(1) The residential sector accounted for approximately 97% of the units as was expected. However, the domestic water heating application produced a smaller percentage than expected with only 55% (80% DHW only and 5% DHW and PH) reporting that their primary system application was domestic hot water.

FSEC Toll-Free Telephone Line continued

(2) A result hidden in the above figures is that 99 of the owners contacting the Center via the toll-free line indicated that they had either built and/or installed their units themselves. This means that 19%, or approximately 1 out of every 5 owners who phoned us, were not involved in a "basic" market transaction in which the owner purchases an already-constructed unit and has it installed by persons other than himself.

(3) In the residential sector, all but 8 units were installed in houses. Six of these eight installed not in houses were installed for individual apartments, condominiums, or townhouses. One was in a mobile home and one was in a park service outpost.

(4) In the pooling heating application, all but three were residential installation.

(C) Date of System Installation (by total number and percentage):

1977-1978	:	271 (52%)
1976	:	80 (15%)
1975	:	53 (10%)
1974	:	20 (4%)
1970-1974	:	9 (2%)
1960's	:	9 (2%)
1950's	:	16 (3%)
1940's	:	33 (6%)
1930's	:	26 (5%)
1920's	:	4 (less than 1%)
prior to 1920's	:	1 (less than 1%)

Comments:

(1) As expected the vast majority, 81%, of the units were installed from 1974 to the present.

(2) An unexpected result is the relatively large number of units predating 1960. Approximately 15%, or every 6th or 7th unit reported, was installed prior to 1960.

(D) Preceived Experience (by total number and percentage):

No problems and Satisfied	:	283 (54%)
Problems but Satisfied	:	115 (22%)
(Total Satisfied)	:	398 (76%)
Problems and Mixed	:	56 (11%)
Problems and Unsatisfied	:	68 (13%)
(Total Reporting Problems)	:	239 (46%)

Comments:

(1) A higher percentage of owners contacting the Center via the Hot Line indicate satisfaction than does the entire sample of owner experiences collected by the Center through all sources: Hot Line, letter, warranty cards, etc.

(2) The total number of owners indicating problems, major and minor,

FSEC Toll-Free Telephone Line continued

is 239 or 46% of all reporting owners.

(3) Of the 98 units installed from 1900-1974, 64 reported no problems and 25 reported problems but satisfied for a total of 89 out of 98 or 91% satisfied. (With the older units the most common, reported problem was rusting of tanks necessitating tank replacement. In general this rusting did not become serious enough to warrant replacement until 15 years or more after installation.)

(4) Of the 99 owners reporting that they had built and/or installed their units themselves, 29 reported problems but only 13 would admit that they were unsatisfied or mixed with their units.

(5) In the "Problems but Satisfied" category, the following specific problems were most frequently mentioned:

Problem	No. of Cases
*Freeze-ups	28
*Sensor	10
Leaking	9

Thus out of 52 total freeze-up cases reported (see Section G), 28 of these owners (or 54%) indicated that even though their units had experienced a freeze-up, they were still completely satisfied with the unit!

* Note: Some owners reported both sensor failure and a freeze-up in this same category.

Also interesting is that of 16 owners who either built and/or installed their units themselves (and who were thus probably much more aware of the internal workings of the system than the average owner would be) and who also reported a freeze-up, 7 reported they were completely satisfied with their units.

(6) In the "Problems and Unsatisfied" category, the following breakdown of unsatisfied cases by system application is possible:

System Application	No. Unsatisfied	Percent of Total Application
DHW	29	7%
PH	23	47%
Space Heating	4	31%
Space Cooling	12	86%

(7) In the "Problems and Mixed" category, the following breakdown of mixed cases by system application is possible:

System Application	No. Mixed **	Percent of Total Application
DHW	40	10%
PH	5	10%
Space Heating	2	15%
Space Cooling	2	14%

** Note: 7 cases in this category fell into the DHW and PH classification and are not included in this tally.

FSEC Toll-Free Telephone Line continued

In this category the specific problems most frequently mentioned were:

Problem	No. of Cases
Freeze-ups	11
Poor installation	5
Not heating to expectations	5

Note: Thus out of 52 total freeze-up cases, 39 owners experiencing this problem report that they are not unsatisfied with their unit because this problem has arisen.

(8) The final breakdown by application and experience is as follows:

Application	% Satisfied	% Unsatisfied	% Mixed
DHW	83	7	10
PH	43	47	10
*** Space Heating	54	31	15
*** Space Cooling	0	86	14

*** Note: With only 13 space heating and 14 space cooling cases reported, these figures are too low to present enough data to make the percentages for these two applications meaningful is a statistical sense. The important point to be gleaned here is that not one solar space cooling unit owner reports satisfaction.

(E) Time After Installation Until Problem Occurred:

Out of the 239 cases indicating problems, many owners were unsure of the exact length of time after installation when the problem surfaced. Many owners would not even hazard a guess as to this time period. The following information was obtained from those 213 owners indicating a reasonable certainty of the length of time involved.

Length of Time After Purchase That Problem Occurred	Total No. of Cases Reporting Reasonable Certainty of Time Period (%)
Within one year	169 (79%)
1-2 years	14 (7%)
2-3 "	6 (3%)
3-10 "	3 (1%)
10-20 "	9 (4%)
20-30 "	6 (3%)
30-40 "	5 (2%)
40- "	1 (less than 1%)

Comment:

Most of the cases reporting problems within one year reported that the problems occurred immediately after installation.

(F) Time After Problem Arose Before Corrected

Out of the 239 cases indicating problems, many owners were unsure of the exact length of time after the problems arose before the problem was corrected. Many owners would not even hazard a guess as to this

FSEC Toll-Free Telephone Line continued

time period. The following information was obtained from 216 owners indicating a reasonable certainty of this length of time. These owners are not the identical group reported in the previous section.

Length of Time After Problem Arose Before Corrected	Total No. of Cases Reporting Reasonable Certainty of Time Period (%)
1 week or less	59 (27%)
1 week-1 month	30 (14%)
1 month-6 months	13 (6%)
6 months-1 year	3 (1%)
Still not corrected	111 (51%)

Comment:

Although the owners of units whose problems have not been corrected will be able to answer with total certainty the question of " when their units' problems were corrected," and thus might have a slightly higher percentage in this category because of this certainty, the number of uncorrected cases is unexpected. This number is 46% of the total number of problem cases reported.

(G) Types of Problems Most Often Reported:

(Total number of cases reporting problems: 239, some of which reported more than one problem.)

Problem Type	No. of Times Reported	Percent of Total Problem Cases
Freeze-ups	52	22%
Water not heated to expectations	33	14%
Water Leakage	28	12%
Poor Installation	27	11%
Unit Never Worked	23	10%
Controller	16	7%
Sensor	15	6%
Service	15	6%
	209	88%

(H) Number of Problems in 7 Problem Category Areas (and percentages):

7 Main Categories	No. of Times Reported	Percent of Total Problem Cases ****
(1) Inadequate System Performance	57	24%
(2) Component or System Design Flaw	151	63%
(3) Installation Problem	27	11%
(4) Inadequate or Unreliable Info.	3	1%
(5) Inadequate information for O&M and Warranty	0	0%
(6) Inadequate or unsatisfactory Repair Service	15	6%
(7) Legal, administrative, and institutional barriers	12	5%

**** Note: Some cases reported more than one problem and thus may fall into more than one problem category.

APPENDIX C

NINETY-FIFTH CONGRESS

JOHN E. MOSS, CALIF., CHAIRMAN

JOE SANTOS, NEV.
THOMAS A. LUKEN, OHIO
DOUG WALGREN, PA.
ALBERT GORE, JR., TENN.
CHARLES J. CARNEY, OHIO
HENRY A. WAXMAN, CALIF.
PHILIP R. SHARP, IND.
ANTHONY TOBY MOFFETT, CONN.
ANDREW MAGUIRE, N.J.
ROBERT (BOB) KRUEGER, TEX.

HARLEY O. STAGGERS, W. VA.
(EX OFFICIO)

JAMES M. COLLINS, TEX.
NORMAN F. LENT, N.Y.
MATTHEW J. RINALDO, N.J.
DAVE STOCKMAN, MICH.
MARC L. MARKS, PA.
SAMUEL L. DEVINE, OHIO
(EX OFFICIO)

CONGRESS OF THE UNITED STATES
HOUSE OF REPRESENTATIVES
SUBCOMMITTEE ON OVERSIGHT AND INVESTIGATIONS
OF THE
COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE
WASHINGTON, D.C. 20515

ROOM 2323
RAYBURN HOUSE OFFICE BUILDING
PHONE (202) 225-4441

JAMES L. MCLAUGHLIN
OPERATIONS DIRECTOR

JOHN MC ELROY ATKINSON
COUNSEL TO THE SUBCOMMITTEE

TASK FORCE DIRECTORS
LOWELL DODGE—OVERSIGHT
JOHN R. GALLOWAY—ENERGY
ELLIOT A. SEGAL—HEALTH

J. THOMAS GREENE
COUNSEL TO THE CHAIRMAN

BERNARD J. WUNDER
MINORITY COUNSEL

MEMORANDUM

DATE: September 18, 1978

TO: John E. Moss, Chairman

FROM: Subcommittee Staff

SUBJECT: Summary of Problems in DOE-Funded Solar Energy Systems

Introduction

Forty operating solar systems funded by the Department of Energy were reviewed from a performance basis. Preliminary results indicate a high percentage of operating problems. The review includes residential and commercial installations covering active air and water systems.

Results

Problem	Number of Systems	Number of Problems
Freezing	37	11 (29.7)
Collector to Manifold Leak	40	15 (37.5)
Controller Malfunction	40	11 (27.5)
Collector Malfunction	40	22 (55.0)
a. Flat Plate Type	36	20 (55.5)
b. Concentrating Type	4	2 (50.0)

Appendix D

The following represent the Subcommittee's efforts in conducting a survey of solar energy consumers in the States of Michigan, Wisconsin and California.

The Subcommittee was assisted in th esurvey by the California Energy Commission and the Mid-American Solar Energy Complex. These organizations provided names of individuals who have solar equipment installed in their homes or businesses, and helped distribute the questionnaires to them. The Subcommittee is very grateful for this assistance.

The Subcommittee also wishes to express its gratitude to two organizations who were instrumental in assisting in formulating and tabulating results of the questionnaire. The Congressional Research Service, in particular Mr. Dan Melnik, Government Division, contributed greatly to the effective design of the questionnaire. The House Information System provided all computer services in tabulating the questionnaire results. Mr. Hillel Sukenik of the HIS professional staff assisted in the design of the final computer output and the formulation of tables and graphs. His participation in this project was invaluable.

The results of the questionnaire have been used extensively to illustrate various topics in this report. The questionnaire contained 77 questions, of which 74 were tabulated by the Subcommittee. A total of 781 questionnaires were sent out; 336 valid responses were returned to the Subcommittee. The questions were designed to measure consumer experience and satisfaction with active solar energy systems.

NINETY-FIFTH CONGRESS

JOHN E. MOSS, CALIF., CHAIRMAN

JIM SANTINI, NEV.
THOMAS A. LUKEN, OHIO
DOUG WALGREN, PA.
ALBERT GORE, JR., TENN.
CHARLES J. CARNEY, OHIO
HENRY A. WAXMAN, CALIF.
PHILIP R. SHARP, IND.
ANTHONY TOBY MOFFETT, CONN.
ANDREW MAGUIRE, N.J.
ROBERT (BOB) KRUEGER, TEX.

HARLEY O. STAGGERS, W. VA.
(EX OFFICIO)

JAMES M. COLLINS, TEX.
NORMAN F. LENT, N.Y.
MATTHEW J. RINALDO, N.J.
DAVE STOCKMAN, MICH.
MARC L. MARKS, PA.
DANIEL L. BOYER, OHIO
(EX OFFICIO)

CONGRESS OF THE UNITED STATES
HOUSE OF REPRESENTATIVES
SUBCOMMITTEE ON OVERSIGHT AND INVESTIGATIONS
OF THE
COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE
WASHINGTON, D.C. 20515

ROOM 2323
RAYBURN HOUSE OFFICE BUILDING
PHONE (202) 225-4441

JAMES L. HERLIHAN
OPERATIONS DIRECTOR

JOHN MC ELROY ATKINSON
COUNSEL TO THE SUBCOMMITTEE

TASK FORCE DIRECTORS
LOWELL COCKE—OVERSIGHT
JOHN R. GALLOWAY—ENERGY
ELLIOT A. SEGAL—HEALTH

J. THOMAS GREENE
COUNSEL TO THE CHAIRMAN

BERNARD J. WUNDER
MINORITY COUNSEL

Respondent's
Identification Number ___ ___ ___ ___

Questionnaire on Solar Energy

The Committee on Interstate and Foreign Commerce of the United States House of Representatives has significant responsibility for making laws relating to the environment of our Nation and our sources of energy. Because of the vital importance of this problem and the need to focus on solutions, the Subcommittee on Oversight and Investigations of that Committee has decided to study the way private citizens currently use solar energy equipment. While only a limited number of privately owned solar systems are now in use, the Subcommittee feels that this source of energy has great potential for contributing to our Nation's welfare.

In line with the Committee's jurisdiction, we are concentrating on the commercial aspects of the use of this technology. As an owner of a solar collector, you can make an important contribution to our efforts by sharing your experience with us. As with any new technology, there is considerable potential for inadequacies in equipment, misunderstandings between buyers and sellers, and unsatisfactory commercial conditions. The danger is that these problems might work to defeat the promise of solar technology. The information you provide on the next pages will be used as a basis for adopting government policies to insure that solar energy users are able to buy and use their equipment in a fair market.

The identification number on the upper right hand corner of this booklet has been affixed to help us administer the questionnaire. Please have the member of your household most knowledgeable of your solar energy systems complete the questionnaire. Your answers will be treated as confidential by the staff and Members of the Subcommittee and only used for statistical analyses.

PLEASE TURN TO THE NEXT PAGE

336 valid cases
responses and
adjusted frequencies

First, we would like to ask you some questions about your experience using solar equipment.

Q1. In general, how satisfied are you with the performance of your solar energy equipment? [Circle your answer]

1 VERY DISSATISFIED	9.3%
2 SOMEWHAT DISSATISFIED	2.4%
3 NEITHER DISSATISFIED NOR SATISFIED	1.2%
4 SOMEWHAT SATISFIED	17.2%
5 VERY SATISFIED	59.3%
6 NOT SURE YET	10.5%

Q2. Which of the following aspects of owning solar energy equipment have you found to be the most rewarding? [Circle one answer only]

1 THE CONTRIBUTION I AM MAKING TO A CLEANER ENVIRONMENT	10.7%
2 THE AMOUNT OF ENERGY I AM SAVING FOR THE NATION	27.2%
3 THE MONEY I AM SAVING	43.1%
4 THE TROUBLE FREE OPERATION OF MY EQUIPMENT	6.4%
5 THE WAY MY EQUIPMENT HAS BEEN SERVICED	.6%
6 OTHER [Please specify] _____	6.1%

Q3. How frequently have you had problems with your equipment? [Circle your answer]

1 EVERY TIME IT IS IN USE	1.2%
2 MOST OF THE TIME	2.1%
3 SOME OF THE TIME	11.6%
4 ONLY IN THE FIRST SIX WEEKS AFTER INSTALLATION	12.5%
5 RARELY	39.9%
6 NEVER	32.0%

Q4. Which of the following aspects of owning solar equipment have you found to be the most troublesome? [Circle your answer]

1 LOCATING RELIABLE EQUIPMENT TO BUY	9.4%
2 HAVING THE EQUIPMENT INSTALLED	6.6%
3 MAINTAINING THE EQUIPMENT IN RUNNING ORDER	10.9%
4 DEALING WITH COMPLAINTS FROM MY NEIGHBORS	.6%
5 OTHER [Please specify] _____	7.6%
6 OWNING SOLAR EQUIPMENT HAS NOT BEEN TROUBLESOME	64.0%

Next, we would like to know what your experience was when you purchased your solar equipment.

Q5. Before you decided to buy your equipment, which of the following sources of information did you use to learn about how solar energy systems work?

	Did you use this source? [Circle your answer]	
1 A friend or neighbor	USED	26.1%
2 A dealer in solar equipment	USED	61.8%
3 A home builder	USED	19.9%
4 The previous owner of the property	USED	2.2%
5 A real estate salesman	USED	5.0%
6 Solar fair or exhibition	USED	37.6%
7 State agencies	USED	17.8%
8 Other Government agency	USED	16.2%
9 An advertisement on radio or TV	USED	5.0%
10 Any other advertisement	USED	20.9%
11 Magazine or journal article	USED	56.5%

Q6. Approximately how much money did you spend for your solar energy equipment? [Circle your answer]

1 LESS THAN $ 500	6.0%
2 BETWEEN $500 AND $1,500	18.6%
3 BETWEEN $1,501 AND $2,500	18.0%
4 BETWEEN $2,501 AND $5,000	25.1%
5 BETWEEN $5,001 AND $8,000	12.6%
6 MORE THAN $8,000	15.0%
7 CAN'T SAY	4.5%

Q7. Did this cost include installation? [Circle your answer]

1 YES → Go to the NEXT page	82.4%
2 NO	16.9%

→ Q8. What was the approximate cost of the installation? [Circle your answer]

1 LESS THAN $250	24.7%
2 BETWEEN $251 AND $500	12.9%
3 BETWEEN $501 AND $750	9.4%
4 BETWEEN $751 AND $1,000	3.5%
5 MORE THAN $1,000	22.4%
6 CAN'T SAY	27.1%

Q9. At the time you purchased your system, were you planning to take advantage of tax credits or cash rebates to defray the cost of your purchase? [Circle your answer]

1 NO → Go to NEXT page, begin question 14 ---------- 43.1%

2 YES ---------- 56.6%

→ Q10. What kind of assistance were you planning to use? [Circle one answer only]

1 ONLY A CASH REBATE ---------- 2.7%
2 ONLY A TAX CREDIT ----------65.6%
3 BOTH A CASH REBATE AND A TAX CREDIT ---------- 8.1%
4 APPROXIMATELY A 25% FEDERAL TAX CREDIT IF CONGRESS PASSED THE LAW ----------12.9%
5 OTHER [Please describe] ---------- 9.1%

Q11. At the time you purchased your equipment, approximately how much money did you think you would receive back as a tax credit or cash rebate?

1 NONE ---------- 3.7%
2 LESS THAN $500---------- 16.0%
3 BETWEEN $501 and $1,000 ---------- 27.3%
4 BETWEEN $1,001 and $2,000 ---------- 27.8%
5 BETWEEN $2,001 and $3,000 ---------- 15.5%
6 BETWEEN $3,001 and $4,000 ---------- 5.9%
7 BETWEEN $4,001 and $5,000 ---------- 2.1%
8 BETWEEN $5,001 and $6,000 ---------- .5%
9 MORE THAN $6,000 ---------- 1.1%

Q12. Would you have purchased your solar energy system if tax credits or rebates had not been available?

1 NO ---------- 40.0%
2 YES ---------- 58.9%

Answer only if you used a cash rebate or tax credit

Q13. Did you learn about the availability of rebates or tax credits from any of the following sources?

	Did you learn from this one?[Circle your answer]	
1 Radio or TV Program.....	YES ------	25.9%
2 Newspaper or magazine article..	YES ------	61.9%
3 An advertisment	YES ------	13.8%
4 Sales brochures.....	YES ------	18.6%
5 Government publication.....	YES ------	27.0%
6 Speech by public official.....	YES ------	20.7%
7 Solar energy equipment salesman.....	YES ------	46.3%
8 Home builder.....	YES ------	15.5%
9 Real estate salesman.....	YES ------	5.3%
10 Other [please describe].....	YES ------	13.4%

_____

_____

_____

Every one should answer the following question.

Q14. Before installing your solar energy system, did you take any of the following measures to conserve energy in your home?

	Did you do this? [Circle your answer]	
1 Added insulation to attic.....YES	----------	66.2%
2 Added insulation to walls.....YES	----------	40.5%
3 Installed weatherstripping around doors or windows.....YES	----------	47.6%
4 Installed insulation around hot water pipes.....YES	----------	44.1%
5 Installed insulation around heating ducts.....YES	----------	37.9%
6 Installed storm windows.....YES	----------	21.9%

7 Other [Please list]_____

_____

Next, we would like to know your opinion about your solar energy equipment as a cost saving device.

Q15. Before you purchased your solar energy system, did you have an estimate of how long it would take to pay back the cost of your system through a savings in energy costs? [Circle your answer]

1 NO	37.6%
2 YES	62.4%

[If you had such an estimate, answer the following questions, otherwise skip to question 18]

Q16. How long did you think it would take? [Circle your answer]

1 TWO YEARS OR LESS	2.4%
1 BETWEEN TWO YEARS AND FIVE YEARS	30.8%
2 BETWEEN FIVE YEARS AND TEN YEARS	38.0%
3 BETWEEN TEN YEARS AND FIFTEEN YEARS	15.9%
4 BETWEEN FIFTEEN YEARS AND TWENTY YEARS	7.7%
5 TWENTY YEARS OR MORE	4.8%

Q17. Who made the estimate for you? [Circle your answer]

1 I MADE IT MYSELF	50.7%
2 SOLAR SALESPERSON	20.0%
3 INSTALLER	.5%
4 INDEPENDENT ENGINEER	2.0%
5 SOLAR SYSTEM MANUFACTURER	8.3%
6 DEVELOPER OR CONTRACTOR	4.4%
7 OTHER [Please specify] _____	14.1%

Q18. When you bought your solar energy system, approximately what percent of your monthly utility costs did you expect to save? [Circle your answer]

1 I DID NOT EXPECT TO SAVE AT ALL	3.7%
2 BETWEEN ONE AND TEN PERCENT	10.2%
3 BETWEEN TEN AND TWENTY-FIVE PERCENT	27.8%
4 BETWEEN TWENTY-FIVE AND FIFTY PERCENT	26.8%
5 BETWEEN FIFTY AND SEVENTY-FIVE PERCENT	14.9%
6 MORE THAN SEVENTY-FIVE PERCENT	3.4%
7 DON'T KNOW	12.2%

Q19. Which of the following sources of information did you use in estimating the amount of utility costs you could save?

	Which ones did you use? [Circle your answer]	
1 Television or Radio program	USED	3.1%
2 Newspaper or magazine article	USED	21.5%
3 An advertisment	USED	6.9%
4 Government publication	USED	14.0%
5 Speech by a public official	USED	2.1%
6 Solar energy equipment salesman	USED	43.4%
7 Home builder	USED	12.8%
8 Real estate salesman	USED	3.8%
9 A developer or contractor	USED	10.3%
10 An independent engineer	USED	17.8%
11 Other(Please describe)	USED	37.3%

Q20. Did you pay for your solar energy system in cash or did you finance it? [Circle your answer]

1 PAID CASH → Go to Question 23 On the next page — 64.4%

2 FINANCED THE PURCHASE — 35.3%

→ Q21. Where did you arrange the financing? [Circle your answer]

1 A COMMERCIAL BANK	17.4%
2 A SAVINGS AND LOAN ASSOCIATION	17.4%
3 A CREDIT UNION	8.3%
4 THE DEALER WHO SOLD IT TO ME	2.4%
5 WAS A PART OF MY MORTGAGE	45.5%
6 OTHER [Please specify] _____	7.4%

Q22. Which statement best describes your experience in obtaining financing for your solar energy equipment?

1 I COULD NOT OBTAIN FINANCING	2.5%
2 I OBTAINED FINANCING AFTER GREAT DIFFICULTY	2.5%
3 I OBTAINED FINANCING AFTER SOME DIFFICULTY	14.3%
4 I HAD NO DIFFICULTY OBTAINING FINANCING	80.7%

Next, we would like to know about your experiences in having your solar energy equipment installed.

Q23. Did you install your solar energy equipment yourself or did you hire someone to do it for you? [Circle your answer]

1 I DID IT MYSELF	29.3%
2 THE QUESTION IS NOT APPLICABLE BECAUSE THE SYSTEM WAS INSTALLED BEFORE I PURCHASED MY HOUSE → Skip to question 28 on the NEXT page	12.7%
3 I HIRED SOMEONE ELSE TO DO IT	57.7%

[Answer the following questions if you hired someone to install your system.]

Q24. Who installed your solar energy system? [Circle as many as apply]

1 GENERAL CONTRACTOR	15.7% *
2 PLUMBING CONTRACTOR	18.9%
3 SOLAR ENERGY EQUIPMENT MANUFACTURER	23.6%
4 SOLAR ENERGY EQUIPMENT VENDOR	55.0%
5 OTHER [Please specify] _____	14.1%

*percentages calculated using 191 as universe

Q25. Who selected your installer? [Circle your answer]

1 I SELECTED THE INSTALLER MYSELF	45.6%
2 DEALER FROM WHOM THE SYSTEM WAS PURCHASED	25.1%
3 MANUFACTURER OR SYSTEMS' VENDOR	12.3%
4 DEVELOPER OR CONTRACTOR	11.3%
5 DON'T KNOW	-
6 OTHER [Please specify]_____	5.2%

Q26. Which of the following state or local government licenses did your solar energy system's installer possess?

	Did he possess this license? [Circle your answer]	
1 General contractor	YES	36.9%
2 Plumber	YES	37.2%
3 Electrician	YES	18.2%
4 Specially trained or certified to install solar energy systems	YES	58.7%

Q27. How well do you think your solar energy system was installed? [Circle your answer]

1 THE SYSTEM WAS INSTALLED PROPERLY	56.4%
2 THERE WERE MINOR MISTAKES DURING THE INSTALLATION	20.8%
3 THERE WERE MAJOR MISTAKES DURING THE INSTALLATION	4.2%

Everyone answer these questions.

Q28. Did the county or city in which you live require a building or other permit to be issued before the solar energy equipment could be installed? [Circle your answer]

1 NO -- 39.7% 2 YES -- 30.9%
3 DON'T KNOW --28.8%

Q29. Was such a permit issued? [Circle your answer]

1 NO	11.0%
2 YES	79.7%
3 DON'T KNOW	9.3%

Q30. Did a city or county building official inspect your solar system before it was put into operation? [Circle your answer]

1 NO	Go to Q32 on the NEXT page	60.6%
2 YES		22.7%
3 DON'T KNOW		16.4%

Q31. Did your system pass the first inspection it received?

1 NO	5.3%
2 YES	94.7%

Next, we would like to know what experiences you have had operating your system.

Q32. How satisfied or unsatisfied are you with the operation of your solar energy system?

1 VERY SATISFIED	52.1%
2 SATISFIED	34.0%
3 UNSATISFIED	4.3%
4 VERY UNSATISFIED	2.1%
5 CAN'T SAY	6.7%

Q33. Do you have an instrument on your solar energy device that indicates when the device is operating or how much energy it provides?

1 NO	21.7%
2 YES	57.1%

Q34. Does your solar energy system have a back-up power unit to provide hot water, space heating or space cooling during cloudy periods or at night?

1 NO → Go to the NEXT page	13.6%
2 YES	86.4%

Q35. What fuel does your back-up unit use? [Circle your answer]

1 ELECTRICITY	29.3%
2 GAS	56.4%
3 OIL	4.2%
4 DON'T KNOW	.7%
5 OTHER [Please specify] _____	9.4%

Q36. Does your back-up unit work automatically, or do you turn it on and off manually? [Circle your answer]

1 IT WORKS AUTOMATICALLY	81.2%
2 IT WORKS MANUALLY	16.5%
3 DON'T KNOW	1.4%

Q37. Which of the following best describes what happens with your system when your back-up system has been turned off for 4 hours on a sunny day during which you have continued normal usage? [Circle your answer]

1 THE UNIT CEASED TO FUNCTION	1.5%
2 THERE WAS A MAJOR DECREASE IN THE AVAILABILITY OF HOT WATER, HEATING, OR COOLING	5.2%
3 THERE WAS A SLIGHT DECREASE IN THE AVAILABILITY OF HOT WATER, HEATING, OR COOLING	11.6%
4 THERE WAS NO CHANGE IN THE AVAILABILITY OF HOT WATER, HEATING, OR COOLING	47.8%
5 I HAVE NEVER TURNED OFF THE BACK-UP SYSTEM	32.5%

[All respondents answer these questions]

Q38. Were you provided with operating and maintenance instructions or an owner's manual for your solar system? [Circle your answer]

1 NO	47.4%
2 YES	52.0%

Q39. Have you used the instructions or manual? [Circle your answer]

1 NO	21.7%
2 YES	78.3%

Q40. How helpful were the instructions?

	Rate each type Circle your answer		
	EXCELLENT	ADEQUATE	INADEQUATE
1 Instructions on operating the system.....	34.6%	61.4%	3.9%
2 Instructions on maintaining the system.....	27.8%	55.6%	16.6%
3 Instructions on diagnosing problems.....	23.8%	49.0%	27.2%
4 Instructions on where to have the equipment serviced...	31.3%	50.7%	18.0%

Q41. Have you ever had a problem with your solar energy equipment?

1 NO → Go to the NEXT page	51.5%
2 YES	48.5%

Q42. When you had a problem, how long did it take to obtain service and correction? [Circle your answer]

1 SERVICE WAS OBTAINED WITHIN 15 DAYS	45.8%
2 SERVICE AND CORRECTION WERE OBTAINED WITHIN 15 DAYS	33.5%
3 NEITHER SERVICE NOR CORRECTION WERE OBTAINED WITHIN 15 DAYS	16.1%

These next questions deal with the warranties provided for your solar energy system.

Q43. Were any written warranties provided for your solar energy system?

1 NO → Go to Q49 on page 14		31.3%
2 YES		61.3%
3 DON'T KNOW		7.4%

Q44. Which of the following provided a warranty?

	Did they provide the warranty? [Circle your answer]	
1 The dealer who sold you the system...	PROVIDED	70.4%
2 The manufacturer who produced your collector.....	PROVIDED	88.4%
3 The manufacturer of other parts	PROVIDED	55.6%
4 The installer.....	PROVIDED	59.3%

Q45. Which of the following is currently covered by a warranty? For each covered one, how long is it covered?

	Is it covered? [Circle your answer]	For how many years? [Answer if its Covered]	
1 The entire system.....	COVERED		73.0%
2 The collector.....	COVERED		91.2%
3 The storage unit.....	COVERED		65.5
4 Other component parts...	COVERED		77.0%
5 The installation.....	COVERED		56.7%

Only answer these questions if your solar equipment is covered by a written warranty; otherwise skip to question 49 on the next page.

Q46. Have you ever had occasion to use your warranty service?
[Circle your answer.]

1 NO → Go to Q49 on the next page.	----------	62.3%
2 YES	----------	37.7%

→ Q47. What happened when you tried to use it?
[Circle your answer]

1 ALL REQUESTS WERE HONORED	----------	88.4%
2 ONE REQUEST WAS NOT HONORED BUT ALL OTHERS WERE HONORED	----------	7.2%
3 MANY REQUESTS WERE NOT HONORED	----------	1.4%
4 NO REQUESTS WERE HONORED	----------	2.9%

Q48. Have any of the following ever failed to honor requests for service covered under a warranty they issued?

	Did they fail to honor the warranty? [Circle your Answer]		
1 The Manufacturer of the Collector	YES	----------	4.3%
2 The Dealer who sold the system	YES	----------	3.0%
3 The Installer	YES	----------	4.2%

When people buy equipment, the seller frequently makes promises about the expected performance of the equipment. In the next set of questions we would like you to compare your experiences with your equipment to the promises which were made when you purchased the equipment.

Q49. How accurate did you find the promises of the seller were in the light of your experience since your purchase? Please rate the accuracy of the claims regarding the following aspects of your equipment. [If you built your own solar equipment, go to Q50.]

	How accurate were the promises? [Circle your answer.]				
	COMPLETELY ACCURATE	ACCURATE	INACCURATE	COMPLETELY INACCURATE	TOO SOON TO TELL
1 The life expectancy of the equipment	5.2%	10.7%	3.0%	1.1%	86.1%
2 Reliability of the equipment.....	17.6%	32.2%	5.2%	.7%	43.8%
3 Maintenance required to keep it running.....	24.0%	32.6%	4.9%	1.9%	36.7%
4 Availablity of service.....	24.7%	33.7%	3.7%	4.1%	33.7%
5 Cost of service.....	19.2%	28.3%	1.9%	1.9%	48.3%

Next, please answer the following questions which deal with problems you may have had with your solar energy equipment.

Q50. How frequently have you had problems with your solar energy equipment?

1 NEVER → Go to the NEXT page	41.7%
2 SELDOM	39.9%
3 OCCASIONALLY	12.0%
4 FREQUENTLY	3.8%
5 ALWAYS	2.2%

→ Q51. How long after installation did problems begin occuring?

1 IMMEDIATELY	26.5%
2 WITHIN TWO WEEKS	16.8%
3 BETWEEN TWO WEEKS AND A MONTH	9.7%
4 BETWEEN A MONTH AND A YEAR	37.3%
5 BETWEEN A YEAR AND FIVE YEARS	8.6%
6 MORE THAN FIVE YEARS	-

Q52. Have you ever observed any of the following happening in your system?

	Has this ever happened? [Circle your answer]	
1 Water or other fluid leaks from the system	YES	34.7%
2 Pump operates on warm days when the sun is not shining	YES	20.5%
3 Pump or fan operates noisily	YES	9.0%
4 Pump or fan operates all the time	YES	6.8%
5 Pump or fan seldom operates	YES	1.4%
6 Pump or fan never operates	YES	1.4%
7 Controller does not activate the pump or fan to provide efficient operation of the system	YES	14.6%
8 Controller fails to initiate freeze protection for the collector	YES	4.0%
9 Controller has been repaired	YES	13.3%
10 Controller has been replaced	YES	10.1%
11 The piping has frozen or ruptured	YES	5.1%
12 The collector has frozen or ruptured	YES	5.1%

Q53. Have any of the following ever occurred?

	Has this ever happened? [Circle your answer]	
1 Water has condensed inside the collector	YES	22.0%
2 House has been damaged during installation of the solar energy system	YES	6.4%
3 Collector has corroded	YES	2.3%
4 Piping or pipe joints have corroded	YES	4.4%
5 Pipes or collector were mounted loosely	YES	12.8%
6 Transparent part of the collector has discolored	YES	5.8%
7 The collector glass or cover has seperated from the collector box	YES	7.2%

Q54. Please describe any other problems you have had with your solar energy system, and your experiences in correcting them.

[76-77]

We would like to know what the reactions of your friends and neighbors have been to your installing a solar energy system.

Q55. Have you ever had any of the following experiences?

	Has this happened to you? [Circle your answer]	
1 Neighbors and friends are anxious to see how your solar energy system works out before deciding to purchase one themselves	HAS HAPPENED	77.5%
2 Neighbors have complained about the appearance of your solar collectors	HAS HAPPENED	3.7%
3 Your solar collectors have been damaged by vandals	HAS HAPPENED	1.5%
4 Neighbors have completed new construction or allowed vegetation to grow in a way that shades your formerly unshaded solar collectors	HAS HAPPENED	1.2%
5 You had difficulty with local zoning laws when installing your solar energy system	HAS HAPPENED	2.2%
6 You had difficulty with restrictive 1/ covenants when you installed your solar energy system	HAS HAPPENED	1.5%
7 Your property tax assesment was increased because you installed a solar energy system	HAS HAPPENED	19.4%
8 You had difficulty in complying with local or Federal ordinances	HAS HAPPENED	2.2%

1/ A restrictive covenant is a promise generally contained in a deed limiting the way you can use your property. Typical of these are set-back and design limitations.

The following information about your solar energy equipment will give us a better understanding of the kinds of equipment owned by the people in our sample.

Q56. For which of the following functions is your solar energy equipment used?

	Is it used for this? [Circle your answer]	
1 To heat water for cleaning and bathing	USED	67.4%
2 To heat the house	USED	43.7%
3 To cool the house	USED	8.6%
4 To heat the swimming pool	USED	36.8%

Q57. How many collector panels does your solar energy system use?....._____

Q58. Approximately what is the total surface area of your collectors?....._____(square feet)

Q59. How many months ago was your solar energy system installed?....._____ (months)

Q60. What kind of solar energy system do you have? [Circle your answer] [If you have both types of systems, please answer all questions relating to each type.]

1 LIQUID --73.4%

→ Q61A. Does your solar energy system have a special storage tank? [Circle your answer]

1 NO ----28.4%
2 YES -- 71.6%

→ Q62A. How many gallons of water does the storage tank hold?

_____(gallons)

2 AIR --18.5% 3 BOTH -- 8.0%

→ Q61B. Does your solar energy system have a way of storing heat? [Circle your answer]

1 NO ----27.1%
2 YES ----72.9%

→ Q62B. How many cubic feet of heat storage material does it hold?

_____(cubic feet)

Q63. In which direction do your solar collectors face?
[Circle the answer which comes closest]

1 SOUTH	66.8%
2 MOSTLY SOUTH	22.4%
3 EAST	.6%
4 WEST	4.2%
5 NORTH	.6%
6 STRAIGHT UP	2.7%
7 DON'T KNOW	.6%

Q64. Does your solar energy system have special features to keep it from freezing? [Circle your answer]

1 NO	43.5%
2 DON'T KNOW	8.7%
3 YES	47.5%

→ Q65. What type of freeze protection does it have?
[Circle all that apply]

1 SYSTEM PUMP OPERATES IN FREEZING WEATHER	24.7%
2 SPECIAL VALVES ARE PROVIDED TO DRAIN THE SYSTEM	13.6%
3 SYSTEM HAS ANTIFREEZE	14.3%
4 SYSTEM DRAINS AUTOMATICALLY	25.3%
5 DON'T KNOW	4.7%
More than one above	17.5%

Q66. Was your system installed at the time when your house was built?
[Circle your answer]

1 NO	58.1%
2 YES	41.9%

Q67. How did you purchase your system?
[Circle your answer]

1 AS A WHOLE SYSTEM	64.9%
2 IN COMPONENT PARTS	15.9%
3 AS A KIT	3.7%
4 AS RAW MATERIALS	14.0%

Q68. From whom did you purchase your solar energy equipment?
[Circle your answer]

1 MANUFACTURER	23.1%
2 DEALER	42.3%
3 WAS PART OF MY HOUSE WHEN I BOUGHT IT	15.7%
4 I BUILT IT MYSELF	11.7%

Q69. What is the name of your solar collectors?

_____
(Collector name)

Q70. Approximately what percent of your monthly utility costs have you saved since installing a solar energy system? [Circle your answer]

	By what percentage per month? Approximately.	
1 COSTS HAVE DECREASED	_____(per month)	60.5%
2 COSTS HAVE INCREASED	_____(per month)	1.3%
3 COSTS HAVE REMAINED THE SAME		4.8%
4 DON'T KNOW		32.5%

Q71. Is the company from whom you purchased your solar energy equipment or system still in business today?

1 YES	81.1%
2 NO	1.6%
3 BUILT SYSTEM FROM SCRATCH	11.0%
4 DON'T KNOW	5.7%

Q72. If you know it, we would like to know the name and address of the company or person who installed your equipment. It may help us in a future planned study of installers and their problems.

67.0% could name their installer

_____(Name of person or company)

_____(Street address)

_____(City)

_____(State)

_____(Zip code)

As a check on our sampling procedures we would very much appreciate your answering the following questions. Your answers will be kept in the strictest confidence.

Q73. In all, how many people live in your house?

1. 4.2%	3. 16.9%	5. 12.0%	
2. 32.1%	4. 24.0%	6. 5.5%	
		7+ 4.9%	

Q74. How many of them are less than 18 years old?

1. 34.2%		3. 6.8%
2. 43.0%		4. 4.4%
		5+ 3.2%

Q75. How adept are you in dealing with mechanical problems? Circle the one statement below that best characterizes your ability to deal with the problems you encounter as an owner of a solar energy system.

1 I WORK IN A TRADE OR PROFESSION WHICH REQUIRES ENGINEERING OR MECHANICAL TRAINING	26.7%
2 I SELL OR SERVICE SOLAR ENERGY SYSTEMS AND CAN WORK ON THEM MYSELF	3.1%
3 I INSTALLED MY OWN SOLAR ENERGY SYSTEM	12.1%
4 I KNOW HOW TO FIX MY SOLAR ENERGY SYSTEM	13.0%
5 I WOULD RATHER NOT BE BOTHERED BY HAVING TO DO MECHANICAL WORK	21.1%
6 I AM NOT GOOD AT FIXING MECHANICAL THINGS	10.2%
7 Non-usable answer (more than one above)	13.7%

Q76. In the last year approximately how much money was earned by all the people living in your house?

1 LESS THAN $12,000	10.1%
2 BETWEEN $12,000 and $20,000	19.5%
3 BETWEEN $20,000 and $35,000	37.1%
4 MORE THAN $35,000	33.2%

Finally, as a person who has had experience using solar energy equipment, in what ways do you think the Federal Government can and should take action to improve the climate for energy conservation and the use of the most appropriate energy equipment?
[Please use this page for your comments or add additional pages]

Tax incentives	* 56.6%	Control mfgr/instlr	3.8%
Deregulate gas	1.5%	Promote passive solar	1.5%
Deregulate oil	.7%	Ensure sun rights	1.9%
Research - impr. effic.	1.5%	Deregulate energy	7.5%
Research - lower cost	1.9%	Minimize legislation	3.8%
Set perform. stnds.	4.9%	Support solar indus.	1.9%
Loans - finan. aid	13.5%	Emphasize energy crisis	1.1%
Publicize/demonstrate	13.1%	Push photovoltaic	.7%
Reduce bldg. code barriers	2.6%	Publish consumer info.	1.1%
Publish designs/descript.	3.8%		
Provide training	2.6%		
R & D	11.2%		
No tax incentives	.7%		
Prohibit ineffic. bldgs.	1.1%		
Misc.	5.6%		
Gov't purchase to reduce cost	3.0%		
Eliminate solar tax	5.2%		

* Percentages calculated using universe of 267 - number of cases making at least one suggestion.

PLEASE RETURN THIS QUESTIONNAIRE IN THE ENVELOPE PROVIDED

NO POSTAGE IS REQUIRED

THANK YOU VERY MUCH FOR ANSWERING THIS QUESTIONNAIRE

APPENDIX E

Certain results of the Subcommittee's questionnaire provided key insights into the active solar industry. These included results with respect to use of back-up systems; warranties; frequency of problems as a function of type of installer; costs of systems; and average utility savings. These results are graphically displayed in this appendix.

BACK-UP SYSTEMS

"Which of the following best describes what happens with your system when your back-up system has been turned off for 4 hours on a sunny day during which you have continued normal usage?" (Q37)

	Hot water	Space heat	Pool	Hot water Space heat	Space heat Space cool	Hot water Space heat Space cool	Hot water Space heat Pool	Hot water Space cool Pool	Hot water Space heat Space cool Pool
Unit ceased to function	0*	1	1	0	0	0	0	0	0
Major decrease in hot water, heating, cooling availability	5	1	3	2	0	1	1	0	1
Slight decrease in hot water, heating, cooling availability	13	0	5	7	0	1	2	0	0
No change in hot water, heating, cooling availability	29	10	17	40	2	9	5	1	3
Back-up system never turned off	32	11	4	18	2	4	4	0	1

* Numbers represent the number of responses in each category

PROBLEMS

"Have you ever observed any of the following happening in your system?" (Q52-53)

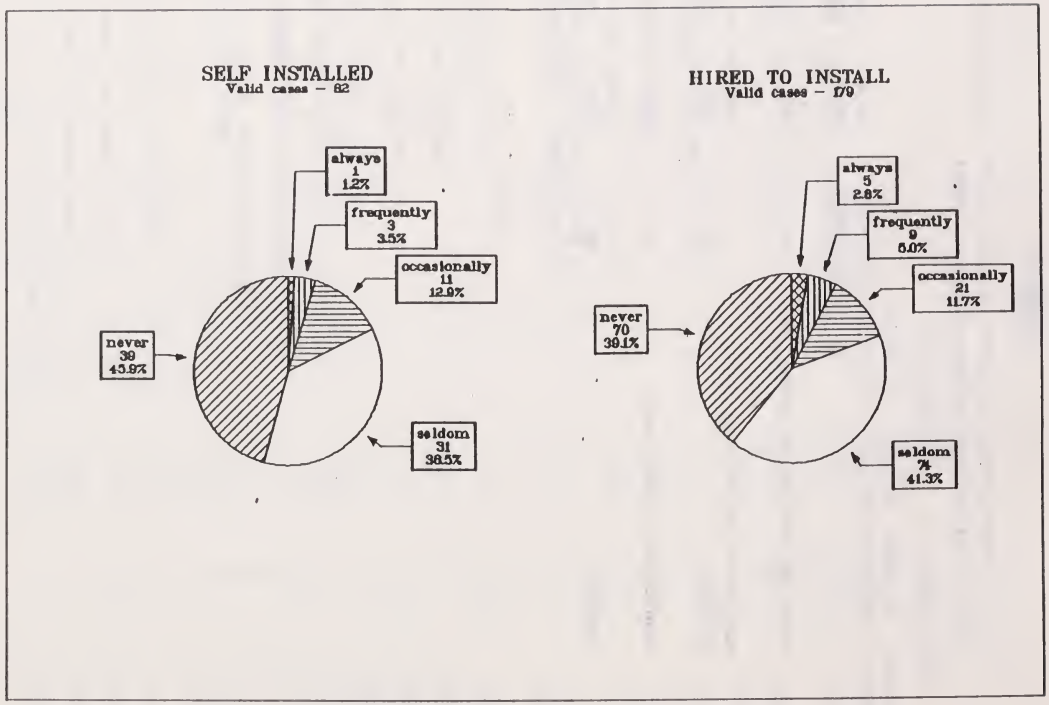
	Self installed		Hired installer	
	Number of respondents	Adjusted frequency	Number of respondents	Adjusted frequency
Water or other fluid leaks from system	26	32.5%	65	36.5%
Pump operates on warm days when the sun is not shining	15	20.5%	39	23.8%
Pump or fan operates noisily	3	3.9%	17	9.8%
Pump or fan operates all the time	0	---	16	9.4%
Pump or fan seldom operates	1	1.4%	3	1.8%
Pump or fan never operates	2	2.7%	4	2.4%
Controller does not activate the pump or fan to provide efficient operation of the system	11	14.3%	31	18.5%
Controller fails to initiate freeze protection for the collector	2	2.7%	6	3.8%
Controller has been repaired	10	13.2%	23	13.7%
Controller has been replaced	6	7.9%	20	11.8%
The piping has frozen or ruptured	3	4.1%	10	5.9%
The collector has frozen or ruptured	5	6.8%	9	5.3%
Water has condensed inside the collector	21	27.6%	39	23.4%
House has been damaged during installation of the solar energy system	2	2.6%	13	7.6%
Collector has corroded	2	2.6%	4	2.3%
Piping or pipe joints have corroded	3	4.1%	7	4.0%
Pipes or collector were mounted loosely	4	5.3%	30	17.4%
Transparent part of collector discolored	5	6.6%	7	4.2%
Collector glass or cover separated from box	4	5.4%	13	7.8%

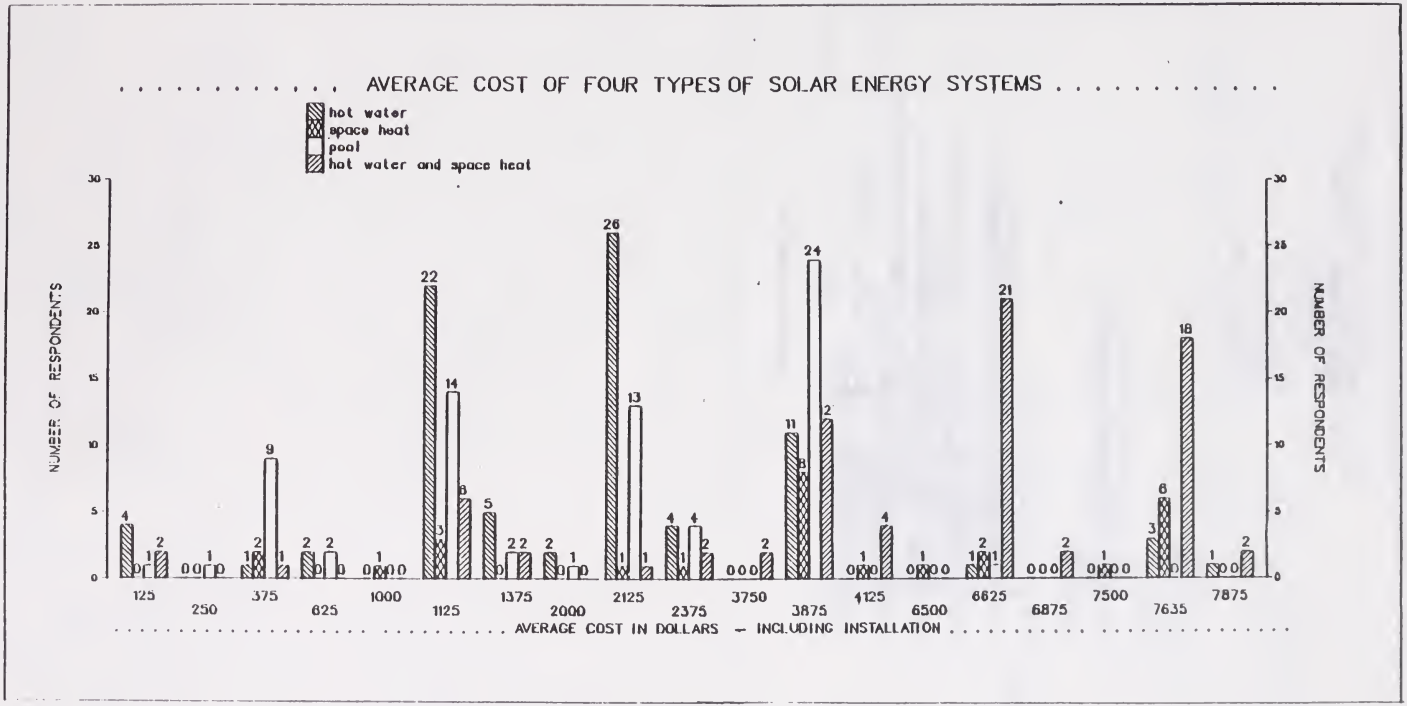
WARRANTIES

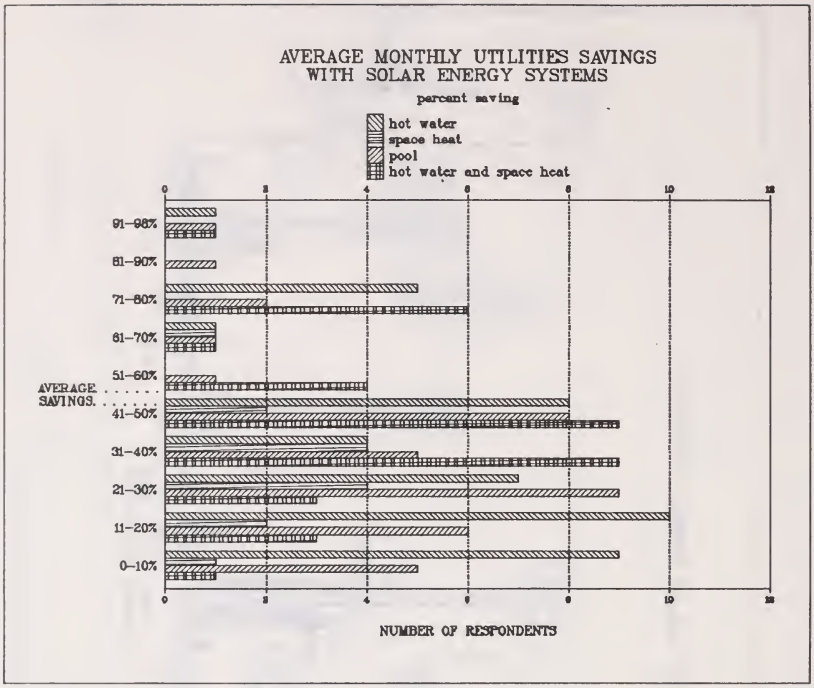
"Which of the following provided a warranty?" (Q44)

	Number of respondents	Valid cases	Adjusted frequency
Dealer who sold you the system	119	169	70.4%
Manufacturer who produced your collector	137	155	88.4%
Manufacturer of other parts	74	133	55.6%
Installer	86	145	59.3%

COMPARISON OF FREQUENCY OF PROBLEMS




AVERAGE COST OF FOUR TYPES OF SOLAR ENERGY SYSTEMS
hot water
space heat
pool
hot water and space heat
NUMBER OF RESPONDENTS
NUMBER OF RESPONDENTS
0
5
10
15
20
25
30
125
250
375
625
1000
1125
1375
2000
2125
2375
3750
3875
4125
6500
6625
6875
7500
7635
7875
AVERAGE COST IN DOLLARS — INCLUDING INSTALLATION


AVERAGE MONTHLY UTILITIES SAVINGS
WITH SOLAR ENERGY SYSTEMS
percent saving
hot water
space heat
pool
hot water and space heat
91–98%
81–90%
71–80%
61–70%
51–60%
41–50%
31–40%
21–30%
11–20%
0–10%
AVERAGE SAVINGS
NUMBER OF RESPONDENTS

COMPARISON OF PROBLEMS IN LAST THREE YEARS
BY TYPE OF INSTALLATION

TYPE OF PROBLEM	HIRED SOMEONE	DID IT THEMSELVES
System leaked water or other fluid	36.5%	32.5%
Pump or fan operates all the time	9.4%	0.0%
Pump or fan noisy	9.8%	3.9%
Controller operates inefficiently	18.5%	14.3%
Controller has been repaired	13.7%	13.2%
Controller has been replaced	11.8%	7.9%
Water condensed inside collecter	23.4%	27.6%
House damaged during installation	7.6%	2.6%
Pipes or collector loosely mounted	17.4%	5.3%
Collector glass or cover has separated from the box	7.8%	5.4%

UNIVERSITY OF FLORIDA
3 1262 09119 2921